Eimac®

TUBE MANUAL

EITEL-McCULLOUGH, INC.
SAN CARLOS • CALIFORNIA

INFORMATION

AS IT APPEARS IN THIS CATALOG

EITEL-McCULLOUGH, INC., SAN BRUNO, CALIFORNIA

(Effective 1-1-55)

general

A QUICK GUIDE TO EIMAC PRODUCTS AND SERVICES OFFERED IN THIS CATALOG

Including...

- Your nearest distributor of modern, fully guaranteed Eimac Vacuum tubes, vacuum capacitors, heat dissipating connectors, air-system sockets, preformed contact finger stock and vacuum switches.
- Your nearest Eimac Field Engineer, who stands ready to give you immediate engineering assistance, any information on deliveries and prices, or provide other information not found in the catalog.
- Eimac tube type numbering system.
- Tube Replacement Chart.
- Prices on Eimac products.

IMPORTANT EIMAC "EXTRAS"

Application Engineering. The Eimac Application Engineering Department is available at all times for consultation. New tube operating techniques are continually being explored, tested and proved by Eimac application engineers, whose combined knowledge and experience are made available to you. Additional contributions by this Eimac department are its Application Bulletins, an expanding service which you get without obligation.

Field Engineering. Serving as an extension of the Application Engineering Department outside the Eimac plant, Eimac field engineers cover the United States, operate out of offices in major cities. They will help you personally with experimental work, problems of technique, etc. Engineers from the Eitel-McCullough plant in San Bruno are available, too, for field consultation throughout the country. As Eimac tubes are world renowned, the same services extend to various countries overseas through the Eimac export division.

general

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac Field Engineers

Serving nine territories throughout the United States are top qualified men, well equipped for electronic factory-field liaison. A phone call or letter to the Eimac field engineer covering your area will bring immediate engineering assistance or information on deliveries and prices. These men are in daily communication with the Eimac factories and have up-to-the-minute information available at their finger tips.

HERB BECKER
1140 Crenshaw Blvd.
Los Angeles 19, California
Phone: WEbster 1-1257

J. E. JOYNER, JR.
2524 Jenny Wren Lane, S. W.
P. O. Box 341, Station A
Atlanta, Georgia
▶ **Phone: FRanklin 4910**

ROYAL J. HIGGINS CO.
10105 South Western Ave.
Chicago 43, Illinois
Phone: CEdarcrest 3-7388

ADOLPH SCHWARTZ
15 Exchange Place
Jersey City 2, New Jersey
Phone: DElaware 3-2424

TIM COAKLEY SALES OFFICE
148 Needham St.
Newton Highlands
Boston 61, Massachusetts
Phone: DEcatur 2-4800

For information concerning your electronic problems or needs solicit the services of these men without any obligation.

▶ **RUSH DRAKE**
1644 - 104th Ave., S. E.
P. O. Box 427
Bellevue, Washington
Phone: GIbson 1611

McLOUD & RAYMOND CO.
5528 East Colfax Ave.
Denver 7, Colorado
Phone: FRemont 7-3067

CLYDE H. SCHRYVER SALES CO.
4550 Main St., Room 224
Kansas City 5, Missouri
Phone: WEstport 4660

JACK YOUNT
1431 Pleasant Drive
Dallas 17, Texas
Phone: EXpress 0988

Export Agents
FRAZAR & HANSEN, LTD.
301 Clay St.
San Francisco 11, California
Phone: EXbrook 2-5112

120 Broadway
New York 5, New York
Phone: WOrth 4-3454

225 West 23rd St.
Los Angeles 7, California
Phone: PRospect 2538

SEE REVERSE SIDE FOR SECTIONAL MAP

Effective 10-1-54
▶ Indicates change from sheet dated 8-11-53

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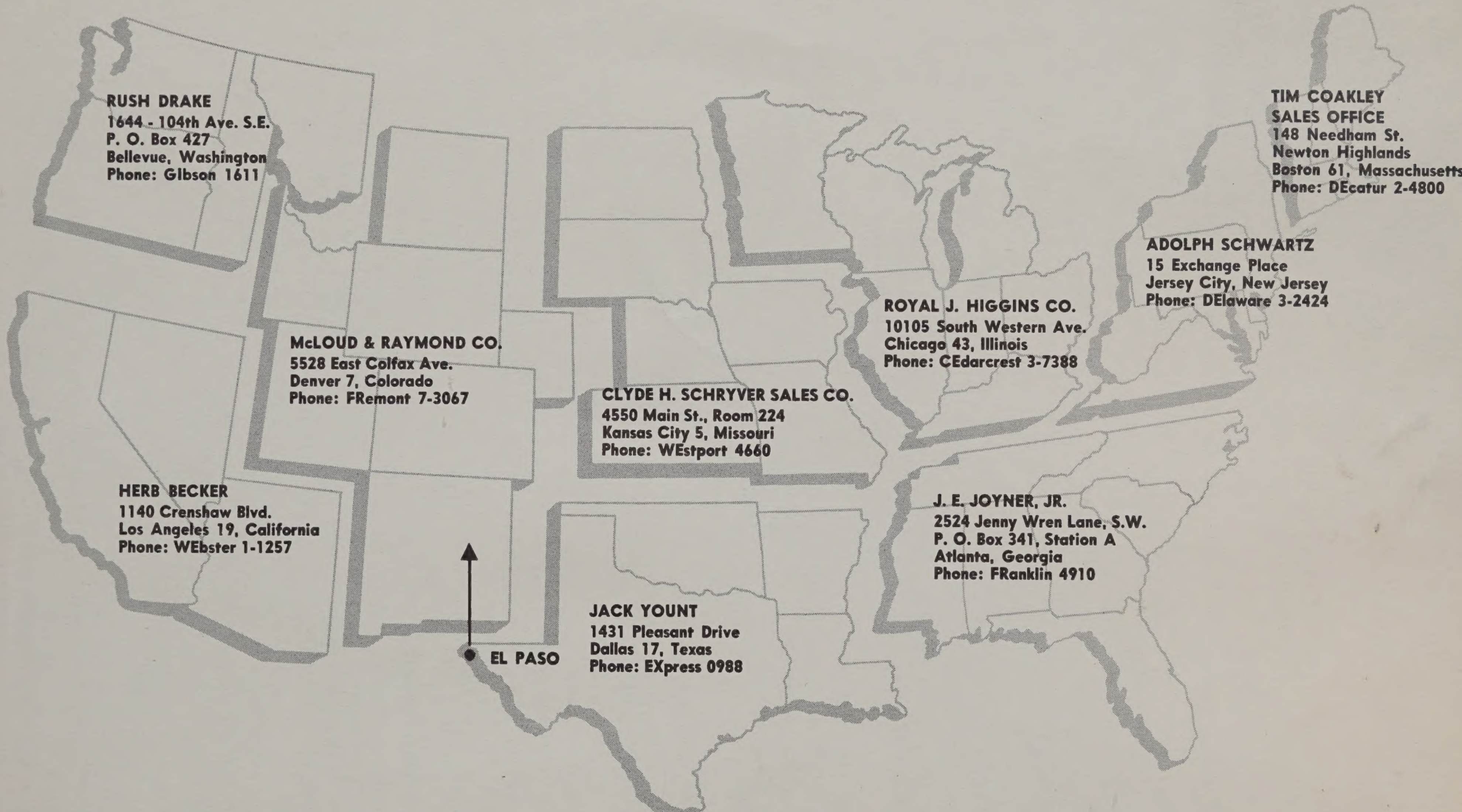
EIMAC FIELD ENGINEERS



Export Agents: FRAZAR & HANSEN, 301 Clay Street, SAN FRANCISCO 11, CALIF. Phone: EXbrook 2-5112
120 Broadway, NEW YORK 5, N.Y. Phone: WOrth 4-3454
225 West 23rd Street, LOS ANGELES 7, CALIF. Phone: PRospect 2538

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac Tube Type Numbering System

Since 1945 all new tube types developed by Eitel-McCullough, Inc., have been given a type number chosen according to a coded numbering scheme. This system is designed to convey descriptive information about the tube.

To illustrate the method of coding and the information the type number conveys, a 2½ kw forced-air cooled Eimac triode, type number 3X2500A3, is broken down as follows:

3X2500A3

Number of Electrodes

2 Indicates Diode
3 Indicates Triode
4 Indicates Tetrode
5 Indicates Pentode
etc.

Plate Dissipation
(Watts)

Mu Group

1 Indicates mu from 0 to 10.
2 Indicates mu from 11 to 20.
3 Indicates mu from 21 to 30.
etc.

Description

*R or –	Radiation cooled, internal anode.
X	External anode, air-cooled tube.
W	Water-cooled anode.
PR	Intended for pulse work, radiation cooled, internal anode.
PX	Intended for pulse work, external anode, air-cooled.
PW	Intended for pulse work, water-cooled anode.

*In type numbers chosen for future tubes, the letter "R" will be used in place of the dash to indicate a radiation cooled tube of the internal anode construction.

Version

Indicates tubes which, although alike as to the number of elements and plate dissipation, are not necessarily interchangeable either electrically or physically.

Printed in U.S.A. 64582

Eimac Tube Type Numbering System for Velocity Modulated Tubes

(Klystron, Travelling Wave, etc.)

To illustrate the method of coding and the information the type number conveys, the Eimac 5 kw output Klystron for the lowest third of the UHF television band, type number 3K20,000LA, is broken down as follows:

3K20,000LA

Number of Cavities

This is the number of interaction regions along the beam. A reflex klystron would be considered to have one interaction space; a travelling wave tube with a distributed circuit would be considered as having "zero" cavities because there are no well defined interaction regions.

Type of Tube

K Klyston
TW Traveling Wave
PK Pulse Klystron
ST Space Charge Travelling Wave Tube.

Dissipation Rating

(Watts)

Frequency Band

Predominately an L-band tube
Predominately an X-band tube
etc.

Version

Indicates tubes which, although alike as to the number of interaction regions, type, dissipation and frequency band, are not necessarily interchangeable either electrically or physically.

Printed in U.S.A. 1-71531

THERE'S AN EIMAC DISTRIBUTOR NEAR YOU

To Be Sure of Eimac Quality, Purchase Eimac Labeled Tubes from These Authorized Distributors

ALASKA

Anchorage
Yukon Radio Supply, Inc.
Box 406

Fairbanks
Yukon Radio Supply, Inc.
655 - 6th Ave.
P. O. Box 1385

Juneau
Alaska Radio Supply, Inc.
Box 2538

ALABAMA

Birmingham
Ack Radio Supply Co.
3010 - 3rd Ave. South

James W. Clary Co.
1713 - 2nd Ave. South

Forbes Distributing Co., Inc.
2600 - 3rd Ave. South

Gadsden
Southeastern Radio Parts Co.
120 Chestnut St.

Mobile
Forbes Electronic Distributors, Inc.
57 N. Washington St.

Montgomery
Nolin-McInnis, Inc.
205 Commerce St.
P. O. Box 2229

Southeastern Radio Parts Co.
210 N. Court St.

ARIZONA

Phoenix
Radio Parts of Arizona
214 South 11th Ave.

Radio Specialties & Appliance Corp.
305 E. Roosevelt

Western Radio & Engineering Co.
1915 East Washington St.

Tucson
Elliott Electronics, Inc.
418 N. 4th Ave.
P. O. Box 5081

ARKANSAS

Blytheville
Blytheville Radio Supply
112 South First St.

Ft. Smith
Wise Radio Suppy
1001 Towson Ave.

Little Rock
Carlton Wholesale Radio, Inc.
606 E. Capitol St.
P. O. Box 828

Southern Radio Supply
1419 Main St.

David White Radio Supply Co.
1222 Main St.

Texarkana
Lavender Radio Supply Co., Inc.
520 East Fourth

CALIFORNIA

Bakersfield
Central Radio & TV Supply
621 - 34th St.

Valley Radio Supply
716 Baker St.

Burbank
Fred S. Dean Co.
1500 W. Burbank Blvd.

Valley Electronic Supply Co.
1302 W. Magnolia Blvd.

Fresno
Jack C. Arbuckle
2330 Kern St.

Harry Dooley Co.
725 "L" St.

Glendale
Hagerty Radio Supply
6826 San Fernando Road

Hollywood
Hollywood Radio Supply, Inc.
5606 Hollywood Blvd.

Los Angeles
California Electronics Supply, Inc.
11801 W. Pico Blvd.

Federated Purchaser, Inc.
911 South Grand Ave.

Henry Radio
11240 West Olympic

Kierulff Electronics, Inc.
820 West Olympic Blvd.

Radio Products Sales, Inc.
1501 South Hill St.

Radio Television Supply Co.
341 W. 18th St.

Shelley Radio Co.
2008 Westwood Blvd.

Long Beach
Fred S. Dean Co.
969 American Ave.

Larry Lynde Electronics
1526 E. 4th St.

Scott Radio Supply, Inc.
266 Alamitos Ave.

Maywood
Kierulff & Company
6058 Walker Ave.

Oakland
W. D. Brill Co.
198 - 10th St.

Elmar Electronics
140 - 11th St.

Palo Alto
Zack Radio Supply Co.
525 High St.

Pasadena
Dow Radio Supply Co.
1759 E. Colorado St.

Electronics Supply Corp.
2615 East Foothill Blvd.

Sacramento
Dunlap Wholesale Radio Co. Inc.
1628 "S" St.

E. M. Kemp Co.
1115 "R" Street

Sacramento Amateur Radio & TV Supplies
3002 Capitol Ave.

Sacramento Electronic Supply Co.
1219 "S" St.

San Bernardino
Kierulff & Company
1123 W. Base Line at "L" St.

San Diego
Electronic Equipment Distributors
140 "B" St.

Shanks & Wright
2045 Kettner Blvd.

Western Radio & Television Supply Co.
1415 India St.

San Francisco
San Francisco Radio Supply Co.
1284 Market St.

Zack Radio Supply Co.
1426 Market St.

San Jose
Frank Quement, Inc.
161 W. San Fernando St.

Peninsula TV & Radio Supply
881 S. 1st

Santa Ana
Radio & Television Equipment Co.
207 Oak St.

Santa Barbara
Channel Radio Supply Co.
523 Anacapa St.

Stockton
B. J. DeJarnatt Wholesale Co.
515 N. Hunter St.

Dunlap Wholesale Radio Co.
27 N. Grant

COLORADO

Colorado Springs
Murray Radio Co.
9 East Vermijo

Denver
Inter-State Radio & Supply Co.
1200 Stout St.

Niles Phonograph & Radio Co.
505-507-509 - 14th St.

Radio Products Sales Co.
1237 - 16th St.

L. B. Walker Radio Co.
854 Broadway

Ward Terry & Co.
70 Rio Grande Blvd.

Grand Junction
Radio & Electronic Supply Co.
511 Ute

Pueblo
L. B. Walker Radio Co.
218 W. 8th St.

CONNECTICUT

Bridgeport
Hatry of Bridgeport, Inc.
1700 Main St.

Hartford
Hatry of Hartford, Inc.
203 Ann St.

R. G. Sceli Co.
1249 Main St.

New Britain
United Radio Supply Co.
47-53 East Main St.

New Haven
Thomas H. Brown Co.
15-25 Whiting St.

Dale Electronic Distributors Div. of Dale-Connecticut, Inc.
150 James St.

Hatry of New Haven, Inc.
77 Broadway

New London
Aikins Electronic Supply Co.
428 Bank St.

Waterbury
The Bond Radio Supply
439 W. Main St.

Hatry of Waterbury, Inc.
89 Cherry St.

DELAWARE

Wilmington
Almo Radio Co.
Cor. 6th & Orange St.

Radio Electric Service Co.
3rd & Tatnall Sts.

FLORIDA

Jacksonville
Kinkade Radio Supply
1402 Laura St.

Southeast Audio Company
930 W. Adams Street

Thurow Distributors, Inc.
956 Liberty St.

Lakeland
Radio Accessories Co.
1050 South Florida Ave.

Miami
Electronic Supply Co.
61 N. E. 9th St.

Herman Radio Supply Co.
1365 N. W. 23rd St.

Thurow Distributors, Inc.
2207 N. E. 2nd Ave.

Orlando
Hammond-Adams, Inc.
9 South Terry St.

Pensacola
Grice Radio & Electronic Supplies
360 E. Wright Street

Thurow Distributors, Inc.
99 So. Alcaniz St.

St. Petersburg
Cooper Radio Co.
648 Second Ave., So.

Tallahassee
Thurow Distributors, Inc.
739 North Monroe

Tampa
Kinkade Radio Supply
1707 Grand Central Ave.

Radio Accessories Co.
417 E. Platt St.

Thurow Distributors, Inc.
121 So. Water St.

West Palm Beach
Goddard Distributors, Inc.
1309 North Dixie

GEORGIA

Albany
Specialty Distributing Co.
131 Flint St.

Atlanta
Specialty Distributing Co.
425 Peachtree St., N. E.

Southeastern Radio Parts Co.
400 W. Peachtree St.

The Yancey Company, Inc.
1500 Northside Dr., N. W.

Augusta
Specialty Distributing Co.
644 Reynolds St.

Columbus
Radio Sales & Service Co.
1326 First Ave.

Macon
Specialty Distributing Co.
539 Arch St.

Savannah
Specialty Distributing Co.
411 E. Broughton St.

Southeastern Radio Parts Co.
38 Montgomery St.

HAWAII

Honolulu, T. H.
Radio-Television Corp., Ltd.
777 Ala Moana

Radio Wholesale & Supply Co.
P. O. Box 3768

IDAHO

Boise
Craddock's Radio Supply
1522 State St.

Kopke Electronics Co.
119 Peasley St.

Idaho Falls
Schwendiman's Wholesale Distributors
380 E. Street

ILLINOIS

Chicago
Allied Radio Corp.
100 N. Western Ave.

J. G. Bowman & Co.
515 E. 75th St.

Chicago Radio Apparatus Co., Inc.
415 South Dearborn St.

Green Mill Radio Supply
145 West 111th St.

Lukko Sales Corp.
5024 Irving Park Rd.

Newark Electric Co.
223 West Madison St.

Star Electronic Distributors, Inc.
7736 South Halsted Street

Stolz-Wicks, Inc.
8110 S. Western Ave.

Walker-Jimieson, Inc.
311 South Western Ave.

Decatur

York Radio Supply Corp.
801 North Broadway

Oak Park

Melvin Electronics, Inc.
238 Chicago Ave.

Peoria

Klaus Radio & Electric Co.
403 East Lake St.

Selectronic Supplies, Inc.
803 S. Adams St.

Warren Radio Co.
308 Oak St.

Quincy

Cooper Supply Co.
419 S. 10th St.

Rockford

H & H Electronic Supply, Inc.
510 Kishwaukee St.

J & M Radio and Television Supplies, Inc.
1133 Railroad Ave.

Springfield

Suter TV Supply
1500 Sangamon Ave.

INDIANA

Anderson

Seyberts Radio Supply
1331 Main St.

Evansville

Ohio Valley Sound Service
20 E. Sycamore St.

Wesco Radio Parts
428-430 Pennsylvania St.

Fort Wayne

Ft. Wayne Electronics Supply, Inc.
223 East Main St.

Warren Radio Co.
1716 South Harrison St.

Indianapolis

Graham Electronics Supply, Inc.
102 S. Pennsylvania St.

Meunier Radio Supply Co.
524 North Illinois

Radio Distributing Co.
1013 N. Capitol Ave.

Muncie

Muncie Electronic Supply
305 North Madison

South Bend

Radio Distributing Co.
432 S. Carroll St.

Terre Haute

Terre Haute Radio
501 Ohio St.

IOWA

Cedar Rapids

Gifford Brown Inc.
726 - 5th St. S. E.

Council Bluffs

World Radio Laboratories, Inc.
3415-27 West Broadway

Davenport

Tri-City Radio Supply, Inc.
1205 E. River Dr.

Des Moines

Gifford Brown, Inc.
1216 Grand Ave.

Radio Trade Supply Co.
1224 Grand Ave.

Dubuque

Boe Distributing Co.
1605 Rockdale Road

Fort Dodge

Ken-Els Radio Supply Co.
501 1st Ave., North

Sioux City

Burghardt Radio Supply of Sioux City
611 - 5th St.

Dukes Radio Co.
209 Sixth St.

Power City Radio Co.
408 Jones St.

Waterloo

Farnsworth Radio & Television
201-205 E. Mullan St.

Ray-Mac Radio Supply Co.
200 Ballou St.

KANSAS

Hutchinson

Acme Radio Supply
327 W. 4th St.

Interstate Electronic Supply Corp.
325 W. 4th St.

Pittsburg

Pittsburg Radio Supply
212 South Broadway

Salina

Western Dist. Radio & Supply Co.
227 North Santa Fe

Topeka

Acme Radio Supply
412 E. 10th St.

John A. Costelow Co. Inc.
125 Kansas Ave.

The Overton Electric Co. Inc.
522 Jackson St.

Wichita

Amateur Radio Equipment Co.
1203 East Douglas

Interstate Electronic Supply Corp.
230 Ida, P. O. Box 2018

Radio Supply Co.
115 Laura St.

KENTUCKY

Lexington

Radio Equipment Co.
480 Skain St.

Louisvillle

P. I. Burks & Co., Inc.
911 West Broadway

Universal Radio Supply Co.
533 South Seventh St.

LOUISIANA

Alexandria

Central Radio Supply Co.
509 Monroe St.

Baton Rouge

Electronic Supply Co.
1751-53 North 21st St.

Louisiana Radio & Television Distributor, Inc.
1645 N. Plank Road

Lafayette

Ralph's Radio Electronic Supply
3004 Cameron St.

Lake Charles

Wholesale Radio Equipment Co.
324 Ryan St.

Monroe

C & O Electronics
500 N. Third St.

Hale & McNeil
421 Walnut St.

New Orleans

Electronic Parts Corp.
223-225 North Broad

Radio Parts, Inc.
807 Howard Ave.

Southern Radio Supply Co.
1900 Tulane St.

Shreveport

Inter-state Electric Co. of Shreveport, Inc.
630 Spring Street

Lavender Radio & TV Supply Co.
936 Milam St.

MAINE

Auburn

Radio Supply Co. Inc.
26 Cross St.

Bangor

Radio Service Laboratory
16 Salem Court

Portland

Maine Electronic Supply Corp.
148 Anderson St.

Radio Service Laboratory
1004 Congress St.

MARYLAND

Baltimore

Kann-Ellert Electronics, Inc.
9 South Howard St

Radio Electric Service Co.
5 North Howard St.

Wholesale Radio Parts Co., Inc.
3311 West Baltimore St.

Cumberland

Zimmerman Wholesalers
162 Bedford St.

Hagerstown

Zimmerman Wholesalers
114 E. Washington St.

Salisbury

Almo Radio Co.
219 Highland Ave.

MASSACHUSETTS

Boston

DeMambro Radio Supply Co.
1111 Commonwealth Ave.

General Electric Supply Corp.
145 North Beacon

Cramer Electronics
811 Boylston St.

The Louis M. Herman Co.
885 Boylston Street

A. W. Mayer Co.
895 Boylston St.

Radio Shack Corp.
167 Washington St.

Radio Wire Television, Inc.
110 Federal St.

Brockton

Ware Radio Supply Co.
913 Center St.

Cambridge

The Eastern Co.
620 Memorial Drive

Electrical Supply Corp.
1739 Massachusetts Ave.

Fitchburg

Hatry & Young of Fitchburg, Inc.
390 Water St.

Holyoke

Springfield Radio Co.
93 High St.

Lawrence

Hatry & Young of Lawrence, Inc.
262 Lowell Street

New Bedford

C. E. Beckman Co.
11 Commercial St.

Pittsfield

Pittsfield Radio Co.
41 West St.

Springfield

T. F. Cushing
349 Worthington St.

Young & Young of Springfield, Inc.
169 Spring Street

Regent Sales Inc.
236 Chestnut St.

Riga Electrical Corp.
376 Worthington St.

Soundco Electronic Supply Co.
147 Dwight St.

Springfield Radio Co.
405 Dwight St.

Westinghouse Electric Supply Co.
46 Hampden St.

Worcester

DeMambro Radio Supply Co., Inc.
222 Summer Street

Radio Electronic Sales Co.
52 Chandler St.

Radio Maintenance Supply Co.
80 Thomas St.

MICHIGAN

Ann Arbor

Purchase Radio Supply
605 Church Street

Wedemeyer Electronic Supply Co.
215 N. Fourth Ave.

Battle Creek

Electronic Supply Corp.
94 Hamblin Ave.

Detroit

M. N. Duffy & Co.
2040 Grand River Ave., W.

Radio Electronic Supply Co.
1112 W. Warren St.

Radio Specialties Co.
456 Charlotte Ave.

Flint

Shand Radio Specialties
2608 Leith St.

Grand Rapids

Radio Electronic Supply Co.
505 Jefferson Ave., S. E.

Kalamazoo

Electronic Supply Corp.
906 East Michigan Ave.

Warren Radio Co.
713 S. Portage St.

Lansing

Wedemeyer Electronic Supply Co.
2005 E. Michigan Ave.

MINNESOTA

Duluth

Lew Bonn Company
228 E. Superior St.

Northwest Radio
123 East First St.

Minneapolis

Lew Bonn Company
1211 La Salle Ave.

Electronic Center, Inc.
107 - 3rd Ave. No.

Northwest Radio & Electronic Supply Co.
52 So. 12th St.

Harry Stark, Inc.
71 S. Twelfth St.

St. Paul

Lew Bonn Co.
141-147 West Seventh St.

Hall Electric
566 North Robert St.

MISSISSIPPI

Jackson

Swan Distributing Co., Inc.
342 N. Gallatin St. P. O. Box 3201

MISSOURI

Butler

Henry Radio
211 North Main St.

Cape Girardeau

Suedekum Electronic Supply Co.
2215 Broadway

Joplin

4-State Radio & Supply Company
201 Main St.

Kansas City

Burstein-Applebee Company
1012-14 McGee Street

Continental Electric Co.
1321 West 13th St.

Electro-Crafts
1305 Swift, North

Radiolab
1612 Grand Ave.

Poplar Bluff

Tri-State Radio & Supply Co.
536 E. Pine Blvd.

St. Joseph

Acme Radio Supply
819-21 S. 8th St.

St. Joseph Radio & Supply Co.
720 S. 9th St.

St. Louis

Ar-Ka Engineering, Inc.
1319 South Vandeventer

Walter Ashe Radio Co.
1125 Pine St.

Ebinger Radio & Supply
2501 S. Jefferson

Interstate Supply Company
4445 Gustine Ave.

Olive Electronics
6711 Olive Blvd.

Radonics
5040 Easton Ave.

Van Sickle Radio Co.
1113 Pine St.

Springfield

Reed Radio & Supply Co.
805 Boonville Ave.

MONTANA

Billings

Electronics Supply Co.
214 Eleventh St., West

Butte

Smith Supply Co.
425 So. Arizona St.

Helena

D. N. Latus Co.
1531 National

Great Falls

Geo. Lindgren Co.
P. O. Box 966

Missoula

Northwest Distributors
509 South Higgins Ave.

NEBRASKA

Lincoln

Hicks Radio Company
1422 "O" Street

Leuck Radio Supply
243 South 11th St.

Omaha

J. B. Distributing Co.
1616 Cass St.

Omaha Appliance Co.
18th & St. Mary's

Radio Equipment Co.
2852 Douglas St.

Scottsbluff

Joachim Radio Supply, Inc.
1913 Broadway - P. O. Box 67

NEVADA

Las Vegas

Electronic Supply Co.
8 E. Charleston

Metcalf's Radio & Sound Supply
2nd & California Sts.

Reno

Ed. Heim Radio & Electronics
1185 Wells Ave.

Osborne & Dermody, Inc.
2300 Valley Road

NEW HAMPSHIRE

Concord

Evans Radio
P. O. Box 312

Dover

American Radio Corp.
Sixth and Chestnut Sts.

Manchester

DeMambro Radio Supply Co.
1308 Elm Street

Radio Service Laboratory
670 Chestnut St.

NEW JERSEY

Atlantic City

Almo Radio Co.
4401 Ventnor Ave.

Radio Electric Service Co.
406 North Albany

Camden

Almo Radio Co.
1133-35-37 Haddon Avenue

Radio Electric Service of New Jersey, Inc.
513-515 Cooper St.

Newark

Federated Purchaser Corp.
114 Hudson St. at Central Ave.

Aaron Lippman & Co.
99-107 Newark St.

Radio Wire-Television, Inc.
24 Central Ave.

New Brunswick

William Radio Supply Co.
265 Woodbridge Ave., Route 43

Trenton

Allen and Hurley
25 South Warren St.

NEW MEXICO

Albuquerque

Midland Specialty Co.
1712 Las Lomas Blvd.

Radio Equipment Co.
523 East Central Ave.

L. B. Walker Radio Co., Inc.
114 W. Granite Ave.

Roswell

Supreme Radio Supply
129 W. 2nd St.

Santa Fe

A-1 Communications Supply Co.
441 Cerrillos Road

NEW YORK

Albany

Ft. Orange Distributing Co., Inc.
904 Broadway

Amsterdam

Adirondak Radio Supply
P. O. Box 88

Binghamton

Federal Radio Sales & Supply Co.
188 State St.

Brooklyn

Acme Electronics Distributors Corp.
76 Willoughby St.

Buffalo

Dymac, Inc.
2329 Main St.

Genesee Radio & Parts Company
205 Genesee St.

Radio Equipment Corp.
147 Genesee St.

Hampstead

Standard Parts Corp.
277 No. Franklin St.

Ithaca

Stallman of Ithaca, Inc.
123-131 South Tioga St.

Jamaica

Harrison Radio Corp.
144 - 24 Hillside Ave.

Norman Radio Distributors, Inc.
94-29 Merrick Road

Peerless Radio Distributors, Inc.
92-32 Merrick Road

New York City

Arrow Electronics Co.
65 Cortlandt St.

Electronics Center, Inc.
118 Duane St.

Federated Purchaser
66 Dey St.

Harrison Radio Corp.
225 Greenwich Street

Harvey Radio Co., Inc.
103 W. 43rd St.

Hudson Radio & Television Corp.
48 West 48th St.

Hudson Radio & Television Corp.
212 Fulton St.

Midway Radio & Television Corp.
60 West 45th St.

Milo Radio & Electronics Corp.
200 Greenwich St.

Radio Wire-Television, Inc.
100 Sixth Ave.

Terminal Radio Corp.
85 Cortlandt St.

Rochester

Rochester Radio Supply Co.
114 St. Paul St.

Syracuse

W. E. Berndt
655 S. Warren St.

Stewart W. Smith, Inc.
325 East Water St.

Utica

Beacon Electronics, Inc.
411 - 419 Columbia St.

Watertown

Wolmar Distributors, Inc.
Div. of Beacon Electronics, Inc.
108 Lincoln Bldg.

White Plains

Westchester Electronic Supply Co.
420 Mamaronock Ave.

NORTH CAROLINA

Asheville

Freck Radio & Supply Co.
38 Biltmore Ave.

Charlotte

Dixie Radio Supply Co., Inc.
715 W. Morehead

Shaw Distributing Co.
205 W. First St.

Southern Radio Corp.
1625 West Morehead

Greensboro

Johannesen Electric Co.
312 - 14 N. Eugene St.

Southeastern Radio Supply Co.
404 North Eugene St.

Raleigh

Allied Electronics
413 - 415 Hillsboro St.

Southeastern Radio Supply Co.
415 Hillsboro St.

Winston-Salem

Dalton-Hege Radio Supply Co.
924 W. 4th St.

NORTH DAKOTA

Fargo

Bristol Distributing Co.
419 N. P. Ave.

Fargo Radio Service Co.
515 Third Ave. N.

Minot

Maytag Electric Co.
Minot

OHIO

Akron

Olson Radio Warehouse, Inc.
73 East Mill St.

The Sun Radio Co.
110 East Market St.

Ashtabula

Morrison's Radio Supply
331 Center St.

Canton

Armstrong's Electronic Center
1261 Cleveland Ave. Northwest

Wireless Radio & Television
117-12th St., N. E.

Cincinnati

Hughes-Peters, Inc.
1128 Sycamore St.

The Mytronic Co.
2145 Florence Ave.

The Schuster Electric Co.
319-21 East 8th St.

Steinberg's, Inc.
633 Walnut St.

Cleveland

Pioneer Radio Supply Corp.
2115 Prospect Ave.

Radio & Electronics Part Corp.
3235 Prospect Ave.

Columbus

Hughes-Peters, Inc.
111 - 117 East Long St.

Thompson Radio Supplies
182 East Long St.

Universal Service
114 N. Third St.

Whitehead Radio Co.
120 E. Long St.

Dayton

Hughes-Peters, Inc.
300 W. 5th at Perry

Srepco, Inc.
314 Leo St.

Stotts-Friedman Co.
135 E. Second St.

Lima

Lima Radio Parts Co.
600 North Main St.

Warren Radio Co.
222 S. Elizabeth St.

Springfield

Standard Radio-Springfield, Inc.
119 West Main St.

Toledo

Lifetime Electronics
1505 Adams St.

Selectronics Supplies Inc.
1320 Madison Ave.

Warren Radio Co.
1002 Adams St.

Youngstown

Radio & Television Parts Co.
230 E. Boardman St.

Ross Radio Company
325 West Federal St.

OKLAHOMA

Oklahoma City

Johnson Wholesale Electronics
416 N. Lee St.

Radio Supply, Inc.
724 N. Hudson

Tulsa

Radio, Inc.
1000 S. Main St.

S & S Radio Supply Co.
537 So. Kenosha St.

OREGON

Eugene

Carlson, Hatton & Hay, Inc.
96 East 10th Ave.

United Radio Supply, Inc.
179 W. 8th St.

Medford

Verl G. Walker Co.
205 West Jackson

Portland

Central Distributors
1331 N. W. Couch St.

Fleming & Company
N. W. Broadway at Flanders

Lou Johnson Co., Inc.
422 N. W. 8th Ave.

Northwest Radio Supply Co.
717 S. W. Ankeny St.

Pacific Stationery Wholesale Radio Dept.
414 S. W. Second Ave.

Portland Radio Supply Co.
1300 W. Burnside St.

Stubbs Electric Co.
33 N. W. Park Ave.

United Radio Supply, Inc.
22 N. W. Ninth Ave.

Salem

Lou Johnson Company
1051 South Commercial St.

PENNSYLVANIA

Erie

J. V. Duncombe Co.
1011 West 8th St.

Warren Radio, Inc.
12th & State Sts.

Eimac TUBES

Harrisburg
- Radio Distributing Co. 915 South 13th St.

Philadelphia
- A. C. Radio Supply Co. 1539 W. Passyunk Ave.
- Almo Radio Co. 509 Arch St.
- Almo Radio Co. 6205 Market St.
- Almo Radio Co. 412-16 North 6th St.
- Consolidated Radio Co. 612 Arch St.
- Herbach & Rademan, Inc. 1204 Arch St.
- Radio Electric Service Co. N. W. Cor. 7th & Arch Sts.
- Radio Electric Service Co. of Penna., Inc. 3412-14 Germantown Ave.
- Albert Steinberg & Company 2520 North Broad St.
- Eugene G. Wile 218 South 11th St.

Pittsburgh
- Cameradio 1121 Penn Ave.
- Tydings Company 5800 Baum Blvd.

Reading
- George D. Barbey Co. 2nd and Penn Sts.

Scranton
- Fred P. Pursell 1221 - 27 N. Washington Ave.
- Scranton Radio & Television Supply Co. 519-21 Mulberry St.

Uniontown
- Zimmerman Wholesalers 55 Morgantown St.

Wilkes-Barre
- Radio Service Co. 346 South Main St.

RHODE ISLAND

Providence
- Wm. Dandreta & Co. 28 Wolcott St.
- DeMambro Radio Supply Co. 90 Broadway
- W. H. Edwards Co. 94 Broadway

SOUTH CAROLINA

Charleston
- Radio Laboratories 215 King St.

Columbia
- Dixie Radio Supply Co., Inc. 1700 Laurel St.
- Southeastern Radio Parts Co. 1608 Gregg St.

Greenville
- Dixie Radio Supply Co., Inc., 306 Wade Hampton Blvd.

Spartanburg
- McElhenney Co., Inc. 481 Union St.

SOUTH DAKOTA

Aberdeen
- Burghardt Radio Supply P. O. Box 342

Sioux Falls
- Power City Radio Co. 209 South First Ave.
- Warren Radio Supply 115 So. Indiana Ave.

Watertown
- Burghardt Radio Supply P. O. Box 41

TENNESSEE

Bristol
- Roden Electrical Supply Co. 104 East State St.

Chattanooga
- Curle Radio Supply 4th & Broad Sts.
- Specialty Distributing Co. 135 Market St.

Jackson
- L. K. Rush Company 206 E. Baltimore St.

Kingsport
- Chemcity Radio & Electric Co. 1019 Bristol Highway

Knoxville
- Chemcity Radio & Electric Co. 12 Emory Park
- Roden Electrical Supply Co. 808 North Central Ave.

Memphis
- Bluff City Distributing Co. 905 Union Ave.
- Lavender Radio Supply Co., Inc. 180 South Cooper St.
- W & W Distributing Co. 644 Madison Ave.

Nashville
- Braid Electric Co. 1100 Demonbreum St.
- Electra Distributing Co. 1914 West End Ave.

TEXAS

Abilene
- R. & R. Electronic Co. 1010 Pine St.

Amarillo
- R. & R. Electronic Co. 707 So. Adams St.
- West Texas Radio Supply 1026 W. 6th St.

Austin
- Hargis-Austin Co. 410 Baylor St.

Beaumont
- Montague Radio Distributing Co. 760 Laurel St.

Brownsville
- Electronic Equipment & Engineering Co. 1152 East Madison St.

Corpus Christi
- Electronic Equipment & Engineering Co. 805 South Staples St.
- Wicks Radio Equipment Co. 513-15 South Staples St.

Dallas
- Adleta Company 1914 Cedar Springs
- Crabtree's Wholesale Radio 2608 Ross Ave.
- Wilkinson Bros. 2406-8 Ross Ave.
- Geophysical Supply Co. 1311 Dallas Ave.
- Harrison Equipment Co. 1422 San Jacinto St.
- Lenert Company 1420 Hutchins
- Sterling Radio Products Co. 1616 McKinney Ave.
- Strauss-Frank Company 4000 Leeland Ave.

Denison
- Denison Radio Supply 310 W. Woodard St.

El Paso
- Electrical & Mechanical Supply Co. 2000 Texas St.
- C. C. McNicol 811 North Estrella
- Midland Specialty Co. 425 West San Antonio St.
- Reeves Radio Supply 720 North Stanton St.

Fort Worth
- Electronic Equipment Co. 917-19 Florence St.
- Bill Sutton's Wholesale Electronics 104 S. Main St.
- Swieco, Inc. 1512 East Lancaster

Houston
- Busacker Electronic Equipment Co. 1721 Waugh Drive

Laredo
- Guarantee Radio Supply Co. 1314 Iturbide St.

Lubbock
- R & R Supply Co., Inc. 1607 Avenue G

McAllen
- Rio Radio Supply Co. P. O. Box 168 608 So. Broadway

Odessa
- Midland Specialty Co. 2101 Andrews Highway

San Angelo
- Gunter Wholesale Co. 606 South Irving St. P. O. Box 1505

San Antonio
- Electronics, Inc. 512 Broadway
- Lamps 'Lectronics Ltd. 828 Brooklyn Ave.

Tyler
- Lavender Radio Supply Co. 503 East Oakwood

Waco
- The Hargis Co., Inc. 1205 Washington Ave.
- Wholesale Electronic Supply 906 Franklin Ave.

Wichita Falls
- Clark & Gose Radio Supply 1203 Indiana Ave.
- Mooney Radio Supply Co. P. O. Box 969 1635 Huff St.

UTAH

Salt Lake City
- O'Laughlin's Radio Supply Co. 113 East Broadway
- S. R. Ross, Inc. 1212 South State St.
- Standard Supply Co. 531 South State St.

VIRGINIA

Bristol
- Bristol Radio Supply Corp. 31 Moore St.

Norfolk
- Radio Equipment Co. 821 West 21st St.
- Radio Parts Distributing Co. 128 West Olney Road
- Radio Supply Company 711 Granby St.

Richmond
- The Arnold Company 2810 West Marshall St.
- Radio Supply Company 3302 West Broad St.
- Wyatt-Cornick, Inc. Grace at 14th St.

Roanoke
- H. C. Baker Sales Co., Inc. 19 Franklin Road

WASHINGTON

Bellingham
- Waitkus Supply Co. 110 Grand Ave.

Everett
- Pringle Radio Wholesale Co. 2514 Colby Ave.

Seattle
- Electronics Supply Corp. 6305 49th Ave., S. W.
- Harper-Meggee, Inc. 960 Republican St.
- Radio Products Sales Co., Inc. 1214 - 1st Ave.
- Seattle Radio Supply, Inc. 2117 - 2nd Ave.
- Western Electronic Supply Co. 717 Dexter Ave.
- Westlake Electronic Supply 511 Westlake Ave., North
- Herb E. Zobrist Co. 2121 Westlake Ave.

Spokane
- Columbia Electric & Mfg. Co. South 123 Wall St.
- Harper-Meggee Co. North 734 Division
- Northwest Electronics Co. North - 102 Monroe St.

Tacoma
- C & G Radio Supply Co. 2502-6 Jefferson Ave.
- A. T. Stewart Co. 743 Broadway

Walla Walla
- Kar Radio & Electric Co. 12th & Pine Sts.

WASHINGTON D. C.

- Capitol Radio Wholesalers 2120 - 14th St. N. W.
- Electronic Wholesalers, Inc. 2345 Sherman Ave., N. W.
- General Electric Supply Corp. 705 Edgewood St. N. E.
- Kenyon Radio Supply Company 2020 - 14th Street, N. W.
- Rucker Radio Wholesalers 1312 14th St., N. W.
- Southern Wholesalers, Inc. 707 Edgewood St. N. E.
- Sun Radio 938 "F" St. N. W.

WEST VIRGINIA

Charleston
- Chemcity Radio & Electric Co. 103 Clendenin St.

Clarksburg
- Trenton Radio Co. 791 Pike St.

Huntington
- Electronic Supply, Inc. 422 Eleventh St.
- King & Irwin, Inc. 316 Eleventh St.

Morgantown
- Trenton Radio Company 300 Grant Avenue

Wheeling
- General Electronics Distributors, Inc. 26 Tenth St.

WISCONSIN

Appleton
- Valley Radio Distributors 518 N. Appleton St.

Madison
- Satterfield Electronics, Inc. 326 W. Gorham St.

Marinette
- G. M. Popkey Co. Main at 9th St.

Milwaukee
- Central Radio Parts Co. 1723 W. Fond du Lac Ave.
- Electronic Expeditors, Inc. 2205 W. Vliet St.
- Radio Parts Co., Inc. 536-538 West State St.

WYOMING

Cheyenne
- Houge Radio & Supply Co. 2008 Carey Ave.

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

TUBE REPLACEMENT CHART

Tubes in the column marked "TYPE REPLACED" should be replaced with "EIMAC TUBE TYPE" shown in the first column. Replacement with the EIMAC TUBE TYPE will require no reductions in voltages or power input or changes in mechanical connections.

Tubes under the heading "NEAR EQUIVALENT" can be replaced with EIMAC tubes provided changes are made in the electrical values or mechanical connections. Where an "X" appears in the "CHANGES REQUIRED" column some change is indicated.

TRIODES

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	CHANGES REQUIRED				
			Ef	Bias	Socket	Plate Connector	Grid Connector
3C24	25TG	3C28					X
	3-25D3	TUF20		X	X	X	X
	VT204	PE130B					X
	24G						
	DR24G						
	PE130A						
2C39A	GE2C39A						
	ML381						
	ML2C39A						
	2C39						
	3X100A11						
	2C38						
	ZP572						
	GL2C39						
3X2500A3		7C24	X		X	X	X
		7C25	X		X	X	X
		WL473	X		X	X	X
3X2500F3		492R	X		X	X	X
25T	3-25A3	HY30Z		X		X	
	3C24	NU30Z		X		X	
	24	809		X		X	
	PE130C	GL809		X		X	
		NU809		X		X	
		WL809		X		X	
		1623				X	
		GL1623				X	
		NU1623				X	
35T	3-50A4	HY40	X			X	
	PE35T	T40	X			X	
		NU40T	X			X	
		HY40Z	X	X		X	
		TZ40	X	X		X	
		NU40TZ	X	X		X	
		T55	X	X		X	
		811	X			X	
		DR811	X			X	
		GL811	X			X	
		NU811	X			X	
		WL811	X			X	
		812	X			X	
		812H	X			X	
		DR812	X			X	
		GL812	X			X	
		NU812	X			X	
		WL812	X			X	
35TG	3-50D4	4C25		X			X
		54		X			X
		356A			X	X	X
		808	X			X	X
		DR808	X			X	X
UH50	VT62						
	3-50G2						
	BW11						
	304B						
	834						

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TUBE REPLACEMENT CHART—TRIODES (Continued)

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	CHANGES REQUIRED				
			Ef	Bias	Socket	Plate Connector	Grid Connector
75TH	3-75A3	HY51A	X			X	X
		NU51A	X			X	X
		HY51B	X			X	X
		HY51Z	X	X		X	X
		TW75	X			X	X
		8005	X			X	X
75TL	3-75A2						
	75T						
100TH	3-1000A4	4C22	X	X		X	X
	VT218	HF100	X	X		X	X
	RK38	T125	X		X	X	X
	DR100TH	254		X	X	X	X
	EE100TH	810	X		X	X	X
		GL810	X		X	X	X
		WL810	X		X	X	X
		227A			X	X	X
		327A			X	X	X
		327B			X	X	X
100TL	RK36	8000	X		X	X	X
	3-100A2	VT127A			X	X	X
	50T						
152TH	3-150A3						
	152H						
152TL	3-150A2						
	152L						
	152T						
592/3-200A3	GL592						
527	3-300G4						
6C21	GL6C21						
250TH	3-250A4	4C32	X			X	X
	VT220	TW150	X			X	X
	RK63	354E				X	X
	454H	354F			X	X	X
		WL463		X	X	X	X
		PE530	X			X	X
		GL592	X		X		
		822S	X			X	X
250TL	3-250A2	4C34	X			X	X
	VT130	HV18	X			X	X
	150T	KU23	X			X	X
	454L	DR200	X			X	X
		EE200	X			X	X
		HF200	X			X	X
		NU200	X			X	X
		T200	X			X	X
		DR300	X			X	X
		EE300	X			X	X
		HF300	X			X	X
		NU300	X			X	X
		354C				X	X
		354D		X		X	X
		WL460	X			X	X
		806				X	X
		GL806				X	X
		WL806				X	X
304TH	3-300A3						
	VT254						
	304H						
	WL535						
304TL	3-300A2						
	VT129						
	304L						
	304T						
	WL525						

TUBE REPLACEMENT CHART—TRIODES (Continued)

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	CHANGES REQUIRED				
			Ef	Bias	Socket	Plate Connector	Grid Connector
450TH	3-450A4 VT108 WL450 F450TH 854H E450TH	833	X		X		X
		357A	X		X	X	X
		833A	X		X		X
		DR833A	X		X		X
		GL833A	X		X		X
		ML833A	X		X		X
		WL833A	X		X		X
450TL	3-450A2 300T 854L						
750TL	3-750A2 1054L						
1000T	3-1000A4 1000UHF						
1500T	3-1500A3						
2000T	3-2000A3	HF3000	X		X	X	X
		ZB3200	X	X	X	X	X

TETRODES

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	CHANGES REQUIRED				
			Ef	Bias	Socket	Plate Con-nector	Grid Con-nector
4PR60A	5D21 715C 4-60A 715A 715B						
4-65A		57	X			X	
4-125A	4D21 4D23 AT340 PE340	4E27		X	X	X	
		RK65			X	X	
		257		X	X	X	
		257B		X	X	X	
		AT257C		X	X	X	
		PE257C		X	X	X	
		813	X	X	X	X	
		VT144	X	X	X	X	
		GL813	X	X	X	X	
		ML813	X	X	X	X	
		NU813	X	X	X	X	
		WL813	X	X	X	X	
		8001		X	X	X	
4X150A		4X100A				X	
4-250A	5D22 5D24	363A	X		X	X	
		GL592	X	X	X	X	
4-400A	4-250A						
4X500A		RK6D22	X	X	X	X	X

PENTODES

Eimac Type	Type Replaced
4E27A/5-125B	257 257B 8001 4E27 5-125B

RECTIFIERS

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	CHANGES REQUIRED				
			Ef	Eg	Socket	Plate Con-nector	Grid Con-nector
2-25A	25R	3B24W	X			X	
		WL579B	X		X	X	
2-50A	35R						
253	HK253	217C	X				
		317C	X				
8020/100R	WL578 GL451 2-100A GL8020 DR8020 EE8020 R6174 100R						
866A/866	VT46A C866A C866 RCA866A UE966 WL866A/866 GL866A/866 NU866A/866 3096 UE966A F366A UX866 RK866 T866A/866 CE866A/866 3572 EE866A/866 CV32 836 3B28 3B27 3B25						

(Continued on Back Page)

RECTIFIERS (Continued)

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	CHANGES REQUIRED				
			Ef	Eg	Socket	Plate Connector	Grid Connector
2-150D	152RA						
250R	2-250A TR40M 371B DR371B NU371B						
2-2000A	2000R						
RX21A	RX21						
KY21A	KY21						
872A	VT42A 872 UE972 NU872A/872 C872A F872A F353A RCA872A F353 T872A/872 3070 GL872A CE872A WL872A/872 F872B BB872A						

CONDENSERS

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT		
		Type	CHANGES REQUIRED	
			Connectors	Spacing
VC6-20	VC6			
VC12-20	VC12	GLIL21 GLIL25	X X	X X
VC25-20	VC25	GLIL22 GL136	X X	X X
VC50-20	VC50	GLIL23 GLIL38	X X	X X
VC6-32	VC6			
VC12-32	VC12			
VC25-32	VC25			
VC50-32	VC50			

TUBE REPLACEMENT CHART—CROSS INDEX

Comparable types arranged in serial order of their dominant number.

FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC
GLIL21	VC12-20	4E27	4E27A /5-125B	VT108	450TH	AT340	4-125A	WL809	25T
GLIL22	VC25-20	5D21	4PR60A	T125	100TH	PE340	4-125A	810	100TH
GLIL23	VC50-20	5D22	4-250A	VT127A	100TL	354C	250TL	GL810	100TH
GLIL25	VC12-20	5D24	4-250A	VT129	304TL	354D	250TL	WL810	100TH
GLIL36	VC25-20	GL6C21	6C21	PE130A	3C24	354E	250TH	811	35T
GLIL38	VC50-20	RK6D22	4X500A	PE130B	3C24	354F	250TH	DR811	35T
2C38	2C39A	7C24	3X2500A3	PE130C	25T	356A	35TG	GL811	35T
2-100A	100R	7C25	3X2500A3	VT130	250TL	357A	450TH	NU811	35T
2-250A	250R	BW11	UH50	VT144	4-125A	363A	4-250A	WL811	35T
GL2C39	2C39A	HV18	250TL	150T	250TL	371B	250R	812	35T
ML2C39	2C39A	TUF20	3C24	TW150	250TH	DR371B	250R	812H	35T
3-25A3	25T	KU23	250TL	152H	152TH	NU371B	250R	DR812	35T
3-25D3	3C24	24	25T	152L	152TL	ML381	2C39A	GL812	35T
3-50A4	35T	24G	3C24	152RA	2-150D	E450TH	450TH	NU812	35T
3-50D4	35TG	DR24G	3C24	152T	152TL	F450	450TH	WL812	35T
3-50G2	UH50	25TG	3C24	DR200	250TL	WL450	450TH	813	4-125A
3-75A2	75TL	HY30Z	25T	EE200	250TL	GL451	8020 / 100R	GL813	4-125A
3-75A3	75TH	NU30Z	25T	HF200	250TL	454H	250TH	ML813	4-125A
3-100A2	100TL	PE35T	35T	NU200	250TL	454L	250TL	NU813	4-125A
3-100A3	100TH	RK36	100TL	T200	250TL	WL460	250TL	WL813	4-125A
3-150A2	152TL	RK38	100TH	VT204	3C24	WL463	250TH	822S	250TH
3-150A3	152TH	HY40	35T	VT218	100TH	WL473	3X2500A3	833	450TH
3-250A3	250TL	HY40Z	35T	VT220	250TH	492R	3X2500F3	833A	450TH
3-250A4	250TH	NU40T	35T	227A	100TH	WL525	304TL	DR833A	450TH
3-300A2	304TL	NU40TZ	35T	HK253	253	PE530	250TH	GL833A	450TH
3-300A3	304TH	T40	35T	254	100TH	WL535	304TH	ML833A	450TH
3-300G4	527	TR40M	250R	VT254	304TH	ZP572	2C39	WL833A	450TH
3-450A2	450TL	TZ40	35T	257	4E27A /5-125B	WL578	8020 / 100R	834	UH50
3-450A4	450TH	50T	100TL	257B	4E27A /5-125B	GL592	592 / 3-200A3	854H	450TH
3-750A2	750TL	HY51A	75TH	PE257B	4E27A /5-125B	GL592	250TH	854L	450TH
3-1000A4	1000T	HY51B	75TH	AT257C	4E27A /5-125B	715A	4PR60A	1000UHF	1000T
3-1500A3	1500T	HY51Z	75TH	PE257C	4E27A /5-125B	715B	4PR60A	1054L	750TL
3-2000A3	2000T	NU51A	75TH	DR300	250TL	715C	4PR60A	1623	25T
3C24	25T	54	35TG	EE300	250TL	R6174	8020 / 100R	GL1623	25T
3C28	3C24	T55	35T	HF300	250TL	804L	450TL	NU1623	25T
3C34	25T	VT62	UH50	NU300	250TL	806	250TL	HF3000	2000T
3X100A11	2C39A	RK63	250TH	300T	450TL	GL806	250TL	8000	100TL
4C22	100TH	RK65	4-125A	304B	UH50	WL806	250TL	8001	4E27A /5-125B
4C25	35TG	75T	75TL	304H	304TH	808	35TG	8005	75TH
4C32	250TH	TW75	75TH	304L	304TL	DR808	35TG	8020	8020 / 100R
4C34	250TL	DR100TH	100TH	304T	304TL	809	25T	DR8020	8020 / 100R
4D21	4-125A	EE100TH	100TH	327A	100TH	GL809	25T	EE8020	8020 / 100R
4D23	4-125A	HF100	100TH	327B	100TH	NU809	25T	GL8020	8020 / 100R

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

PRICE

January 1, 1955

VACUUM TUBES

1K015XA	$ 180.00
1K015XG	180.00
2-01C	15.25
2-25A	11.00
2-50A	13.75
2-150D	19.25
2-240A	40.00 ~~66.00~~
2-2000A	214.50
2C39A	24.00
3C24	12.00
3K20,000LA	2,975.00
3K20,000LF	2,975.00
3K20,000LK	2,975.00
3K50,000LA	4,200.00
3K50,000LF	4,200.00
3K50,000LK	4,200.00
3K50,000LQ	4,200.00
3W5000A3	198.00
3W5000F3	198.00
3W10,000A3	957.00
3X2500A3	198.00
3X2500F3	198.00
3X3000A1	198.00
3X3000F1	198.00
4-65A	20.00
4-125A	30.25
4-250A	41.25
4-400A	60.50
4-1000A	132.00
4E27A/5-125B	35.75
4PR60A	90.00
4W20,000A	1,850.00
4X150A	41.50 ~~48.00~~
4X150D	41.50 $ ~~48.00~~
4X150G	54.00
4X500A	121.00
4X500F	93.50
6C21	77.00
KY21A	13.25
RX21A	9.00
25T	9.00
35T	10.50
35TG	16.00
75TH	13.25
75TL	13.25
100TH	18.25
100TL	18.25
152TH	28.75
152TL	28.75
250R	22.00
250TH	33.00
253	20.50
304TH	60.50
304TL	60.50
450TH	77.00
450TL	77.00
592/3-200A3	30.25
750TL	137.50
866A	2.45
872A	8.20
1000T	137.50
1500T	220.00
2000T	275.00
8020(100R)	15.00

VACUUM CAPACITORS

VC6-20	$15.00
VC6-32	17.25
VC12-20	16.50
VC12-32	20.00
VC25-20	20.00
VC25-32	23.25
VC50-20	$ 24.25
VC50-32	27.50
VVC60-20	66.00
VVC2-60-20	147.50
VVC4-60-20	284.00

HEAT DISSIPATING CONNECTORS

HR-1	$ .60
HR-2	.60
HR-3	.60
HR-4	.80
HR-5	.80
HR-6	$ .80
HR-7	1.60
HR-8	1.60
HR-9	3.00
HR-10	1.60

AIR SYSTEM SOCKETS

4-400A/4000	$16.00
4-400A/4001	12.00
4-400A/4006*	6.00
4-1000A/4000	22.50
4-1000A/4001	17.00
4-1000A/4006*	7.50
4X150A/4000	18.00
4X150A/4001	17.50
4X150A/4006*	.60
4X150A/4010	20.15
4X150A/4011	19.70

*Replacement Chimneys

PREFORMED CONTACT FINGER STOCK

17/32" - - - -	$1.65/ft.
31/32" - - - -	1.80/ft.
1-7/16"- - - -	2.00/ft.

VACUUM PUMP & GAUGE

HV-1	$125.00
Pump Oil - Qt.	5.00
100 IG	22.50

VACUUM SWITCH

VS-2	$18.00
VS-5	24.00
VS-6	32.00
12V Coil	7.50
24V Coil	8.50

TUBE EXTRACTOR

Tube Extractor for 4X150A, 4X150D, 4X150G	$ .55

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Printed in U.S.A. 6-84845

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

USER PRICE

October 15, 1960

VACUUM TUBES

1K015CA	$ 618.00
1K015CG	618.00
1K20KA	475.00
1K20XD	475.00
1K20XK	475.00
1K20XS	475.00
1K75CH	810.00
1K75CK	810.00
1K125CA	298.00
1K125CB	298.00
1K125CC	730.00
2-01C	18.50
◆ 2-25A	20.00
◆ 2-50A	23.00
2-150D	38.55
2-240A	42.85
◆ 2-450A	113.00
2-2000A	228.00
2C39A	22.50
◆ 2C39WA	32.00
2X1000A	127.50
◆ 2X3000F	168.00
322	25.80
3C24	16.05
◆ 3CPN10A5	32.00
◆ 3CW20,000A3	560.00
◆ 3CX100A5	32.00
◆ 3CX10,000A3	468.00
3K2500LX	2,360.00
3K2500SG	2,950.00
3K3000LQ	2,360.00
◆ 3K50,000LA	4,200.00
3K50,000LF	4,200.00
3K50,000LQ	4,200.00
3KM3000LA	2,470.00
3KM4000LT	1,880.00
3KM50,000PA	11,000.00
◆ 3W5000A1	237.00
◆ 3W5000A3	225.00
◆ 3W5000F1	243.00
◆ 3W5000F3	231.00
3X100A5	25.00
◆ 3X2500A3	200.00
◆ 3X2500F3	206.00
◆ 3X3000A1	212.00
◆ 3X3000F1	218.00
◆ 4-65A	28.50
4-125A	$ 36.00
4-250A	46.50
4-400A	48.00
4-1000A	132.00
4CN15A	55.00
◆ 4CW2000A	218.00
◆ 4CW10,000A	576.00
4CX125C	55.00
◆ 4CX250B	39.35
◆ 4CX250F	39.35
4CX250K	64.25
◆ 4CX250M	92.50
4CX300A	55.00
4CX1000A	156.00
4CX5000A	495.00
◆ 4CX10,000D	550.00
◆ 4E27A/5-125B	50.00
◆ 4K50,000LQ	3,760.00
4KM3000LQ	3,750.00
4KM3000LR	2,420.00
4KM50,000LA	4,230.00
4KM50,000LQ	3,760.00
◆ 4KM170,000LA	20,500.00
4KMP10,000LF	10,800.00
4PR60A	100.00
◆ 4PR65A	35.75
◆ 4PR125A	50.00
4PR400A	60.00
4PR1000A	145.00
◆ 4W300B	57.00
◆ 4W20.000A	1,950.00
◆ 4X150A	25.00
◆ 4X150D	28.00
4X150G	58.00
4X250B	42.50
4X500A	128.50
6C21	82.50
6K50,000LQ	8,250.00
◆ 25T	18.50
◆ 35T	21.50
35TG	36.00
◆ 75TH	30.00
◆ 75TL	30.00
◆ 1001G	107.00
100TH	23.60
100TL	23.60
152TH	75.00

All Prices subject to change without notice. Minimum factory order $10.00

◆ Indicates change from sheet dated March 15, 1960

(Continued)

VACUUM TUBES (continued)

	152TL	$ 75.00
◆	250R	38.55
◆	250TH	38.55
◆	250TL	38.55
◆	253	37.25
◆	304TH	64.50
◆	304TL	64.50
	450TH	77.00
	450TL	77.00
◆	592/3-200A3	46.00
◆	750TL	150.00
◆	1000T	150.00
◆	1500T	279.00
◆	2000T	387.00
	7034	see 4X150A
	7035	see 4X150D
	7203	see 4CX250B
	7204	see 4CX250F
	7289	see 3CX100A5
◆	7580/4CX250BA	45.00
◆	8020(100R)	21.50
◆	KY21A	26.75
◆	RX21A	25.75

PREFORMED CONTACT FINGER STOCK
(Available in 3-Foot Lengths Only)

			per piece
◆	CF-100	17/32"	5.77
◆	CF-200*	13/16"	6.70
◆	CF-300	31/32"	6.23
◆	CF-400*	1-17/32"	8.30
◆	CF-500	1-3/8"	6.70
◆	CF-600*	2-1/4"	9.23
◆	CF-700	17/32"	6.23
◆	CF-800	23/32"	6.23
◆	CF-900	31/64"	5.77

*Double-sided

UNTREATED FINGER STOCK (Punched and formed, not heat-treated or plated) Available in 3-foot lengths only).

◆	CF-101	17/32"	4.92
	CF-301	31/32"	5.77
	CF-501	1-3/8"	6.23

AIR SYSTEM SOCKETS

	SK-300	107.15
	SK-400	17.65
	SK-500	20.70
	SK-600	11.90
	SK-602	11.90
	SK-610	12.65
	SK-620	16.80
	SK-630	18.85
	SK-640	5.35
	SK-650	8.60
◆	SK-655	$ 5.85
	SK-700	21.45
	SK-710	21.45
◆	SK-711	26.50
	SK-740	9.80
	SK-760	9.80
	SK-770	9.80
	SK-800A	55.70
	SK-810	55.70
◆	SK-890	65.00
	SK-900	68.55
◆	SK-1300	64.50

CHIMNEYS FOR AIR SYSTEM SOCKETS

	SK-306	6.45
	SK-406	8.60
	SK-506	15.35
	SK-606	.65
	SK-626	.80
	SK-636	7.07
	SK-806	8.55
	SK-906	11.43
◆	SK-1306	6.45

HEAT DISSIPATING CONNECTORS
(Alodine Finished)

◆	HR-1	1.10
◆	HR-2	1.20
◆	HR-3	1.20
◆	HR-4	1.20
◆	HR-5	1.20
◆	HR-6	1.20
◆	HR-7	1.65
◆	HR-8	1.65
◆	HR-9	2.80
◆	HR-10	1.65

TUBE EXTRACTOR

For 4X150, 4X250 and 2C39 Series

◆	SK-604	.57

4X150G COLLETS

◆	Collet 008290	3.20
◆	Collet 008291	3.20
◆	Collet 008292	4.00
◆	Collet 882931	4.00
◆	Collet 008294	4.00

VACUUM SWITCH

◆	VS-2	28.50
	VS-4	29.00
	VS-5	38.55
	VS-6	34.25
	12V Coil	10.29
	24V Coil	10.29

All Prices subject to change without notice. Minimum factory order $10.00

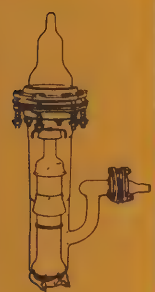
◆ Indicates change from sheet dated March 15, 1960

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

VACUUM PUMP PRICE LIST

June 1, 1950

HV-1 OIL DIFFUSION PUMP



A glass barrel, triple-jet, air-cooled vacuum pump of the oil-diffusion type. Ultimate vacuum of 4 x 10^{-7} mm of mercury. Speed without baffle approximately 67 liters per second. Simple to operate, requires no intricate adjustment or special tools for assembly. Heater voltage 110 volts. Current 1.7 amperes. Overall length below high-vac manifold 16½". Shipping weight 18 pounds. Complete assembly includes flanges and nipples for connecting to high-vac manifold and forepump system, together with necessary gaskets and complete operating instructions.

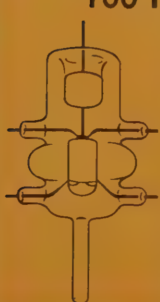
PRICE $125.00

TYPE A PUMP OIL

An especially prepared petroleum product compounded to afford ultimate in high vacuum. Absence of "light ends" eliminates oil contamination to high vacuum system without use of liquid air or charcoal traps.

PRICE, QT. $5.00

100 IG ION GAUGE



Essentially a triode vacuum tube with a pure tungsten filament for measuring pressures from 10^{-3} to less than 10^{-8} mm of mercury. Constructed of "hard" glass for sealing to nonex glass vacuum systems.

PRICE $22.50

HV-1 PUMP PARTS

EIMAC PART NO.	NO. REQ.	DESCRIPTION	PRICE EACH
D-3	2	Neoprene Gasket for 3" Coupling	$ 1.65
4911	1	Jet Assembly	40.00
D-9	1	Neoprene Gasket for 1" Coupling	1.25
917	1	Pump Barrel Assembly	70.00
914	1	Manifold Adaptor	20.00
8911	1	Forevac Nipple	15.00
D-15	2	1" Insert	.45
D-22	2	3" Insert	.75
911	1	Baffle Assembly	8.50
7912	1	3" Flange Assembly*	25.00
7913	1	1" Flange Assembly*	10.00
D-10	6	Springs	.10

*Each flange assembly includes necessary flanges, gaskets, inserts, bolts and hardware.

The Eimac HV-1 vacuum pump and its allied components have for many years been the standby for one of the most exacting of vacuum techniques—the evacuating of radio transmitting tubes on a production basis. They have also been thoroughly proven in many other fields of endeavor.

The Eimac engineering staff will gladly supply further information to assist in your employing the HV-1 to fulfill your vacuum requirements.

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

Printed in U.S.A. 2-64581

APPLICATION BULLETIN

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

NUMBER 1
CRYSTAL CONTROLLED DIATHERMY

THE APPLICATION OF CRYSTAL CONTROL TO DIATHERMY

The obvious advantages of operating diathermy and r-f heating equipment within the frequency bands recently assigned for this service by the FCC makes the use of crystal control attractive, if economically feasible. This bulletin describes a 400 to 500-watt crystal-controlled diathermy unit employing an Eimac 4-250A tetrode as a power amplifier in the output stage. The unit provides for the necessary frequency stability, control of output, circuit simplicity and safety to both operator and patient. Due to the low driving power requirements of the 4-250A, a minimum of equipment is needed for adequate frequency control. The exciter unit consists mainly of receiving type tubes and small parts. The complete unit is no larger than many existing outmoded self-controlled oscillators serving the same purpose. As the frequency is controlled within a band assigned for diathermy use, shielding is not required to prevent interference with communication services.

CIRCUIT

The circuit (Fig. 5) employs a crystal having a fundamental frequency one-fourth the output frequency of 27.32 Mc. This scheme would be applicable to either of the other two assigned diathermy frequencies, 13.66 Mc. or 40.98 Mc., as crystals having fourth harmonics within this range are available.[1] The oscillator stage employs a 6AG7 operating as a Pierce oscillator in the grid-screen section, and doubling in the plate circuit. This is followed by a 6L6 doubler stage. With approximately 425 volts plate supply for these two tubes, the 6L6 easily delivers adequate grid excitation to the 4-250A.

The plate of the 4-250A is shunt-fed through an r-f choke, to allow d-c grounding of the plate tank circuit, as a safety measure. The maximum plate voltage applied to the 4-250A is 3000 volts. Power is taken from the output circuit via a matching network which allows an efficient transfer of energy for various forms of application. A small pilot lamp inductively coupled to the output leads indicates presence of maximum output to the patient, while a plate-current meter indicates the degree of loading.

The 4-250A does not require neutralization at the frequency on which this unit operates, if reasonable precautions are taken regarding by-passing and shielding. All r-f circuits preceeding the 4-250A have been placed under the chassis, to prevent capacitive coupling around the power amplifier stage. The 6L6 in the doubler stage is of the metal-envelope type, with the envelope grounded via a short lead, to prevent capacitive coupling between the plate of the 4-250A and the plate of the 6L6. The filament and screen by-pass capacitors in the 4-250A stage are returned to ground by short, direct leads.

It has been found that the 4-250A plate circuit, once set for resonance, needs no further adjustment with changes in loading. The plate tank capacitor control might well be placed behind the panel out of immediate reach, as it is not required as an operating control.

CONSTRUCTION

A wooden cabinet 16 by 22 by 48 inches houses the equipment. Space is available for the storage of cords and pads in a small cupboard below the control panel. Two chassis 17 by 13 by 3 inches, one for the r-f section, the other for the low and high power supplies, provide ample space for construction. The power supply chassis rests on cleats provided at the base of the unit, while the r-f section is situated behind the control panel to which it is attached. The two units may be removed through the rear of the cabinet, which is normally covered with a single partition. As air cooling of the 4-250A base structure is required, and envelope cooling is advisable, a unique ventilating system has been incorporated in the diathermy unit to provide both types of cooling. A 15 by 20 by 2 inch glass-type dust filter is located in the bottom of the cabinet, below the power supply. Air is drawn by a 6-inch fan through the filter, around the power supply chassis, up behind the storage space, and exhausted through a screened opening six inches in diameter behind the r-f section. The fan is centered in this opening but is attached to the side of the cabinet, allowing easy removal of the rear partition when desired. Air, in passing into the upper section of the cabinet, is also drawn under the r-f chassis and through the socket in sufficient quantity to provide adequate cooling of the 4-250A base structure. The r-f chassis does not completely block the flow of air into the upper section containing the fan and outlet opening, as the entire volume of air is not required to cool the tube base.

CONTROLS

The output to the applicator pads is smoothly controlled by a continuously variable autotransformer in the high voltage transformer primary. Since the 4-250A screen voltage is obtained by means of a series dropping resistor from the plate supply, no separate control is required for screen voltage, and the voltage on the screen due to changes in the loading preliminary to or during treatment is self-regulating to the extent that no adjustment is necessary. The main controls for adjustment to the patient are a time switch as a guard against overdose due to unintentional duration of treatment, the autotransformer power adjustment, and the output load matching control. As a precaution against maladjustment, an overload relay protects the equipment. A reset button for the overload relay is provided on the control panel.

RESULTS

The output has been found to be more than ample for normal therapeutic treatment. In many cases a smaller tube such as the Eimac 4-125A in the amplifier would deliver adequate power, with a resulting saving in the cost of the tube and certain components.

Tests on frequency stability indicate that there is no appreciable change in frequency either from varying load conditions or from drift due to temperature changes. The frequency drift during the first ten minutes from a cold start measured approximately 800 cycles at the output frequency of 27.32 Mc. The frequency shift from changes in loading and power was so slight as to be inconsequential. Stability of this sort is a great improvement over self-controlled oscillator devices, many of which shift frequency violently, often rendering whole bands of communications frequencies completely useless.

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[1] The sixth harmonic, using the combination of 3X in the 6AG7 and 2X in the 6L6, would lower the crystal frequency still further, if desired and yet provide ample excitation for the 4-250A.

FIG. 1—Front view of the experimental crystal-controlled diathermy unit. Apparatus on the panel includes, autotransformer control, PA plate meter, output tuning control, interval timer, PA plate tuning control, output jacks, output indicator lamp, oscillator and doubler tuning controls (screwdriver adjustment), power switches and pilot lamps.

FIG. 2 Complete r-f section of the diathermy unit. The two tuning capacitors for the output network are visible at the upper left of the panel. One of the capacitors is used as a fixed padding capacitor, the other is adjustable from the front panel.

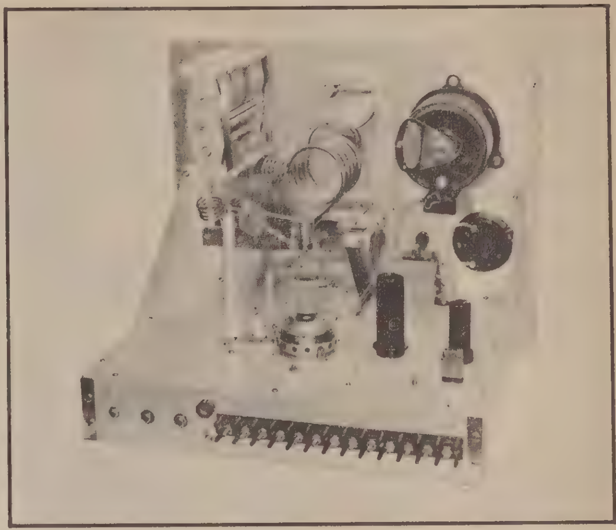
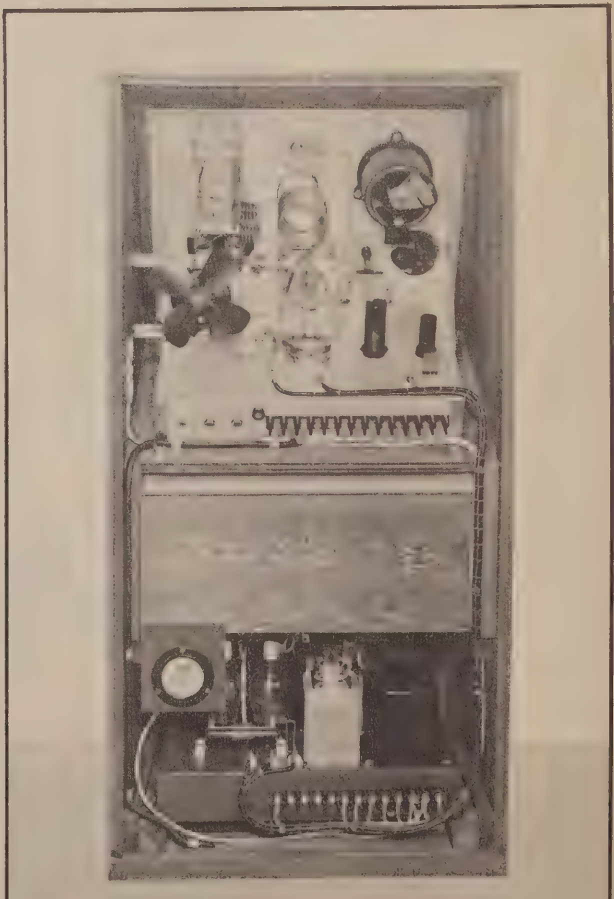


FIG. 3—Rear view of diathermy unit (rear partition removed). Removing the rear partition allows access to exciter-section metering jacks, fuses, and overload relay shunt. Note exhaust fan supported from left side of cabinet.



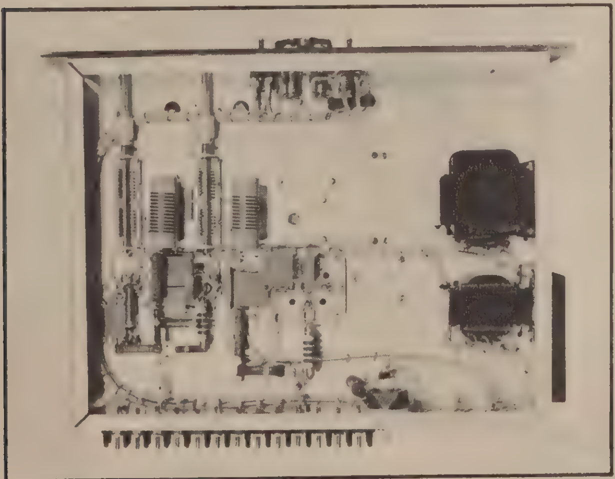
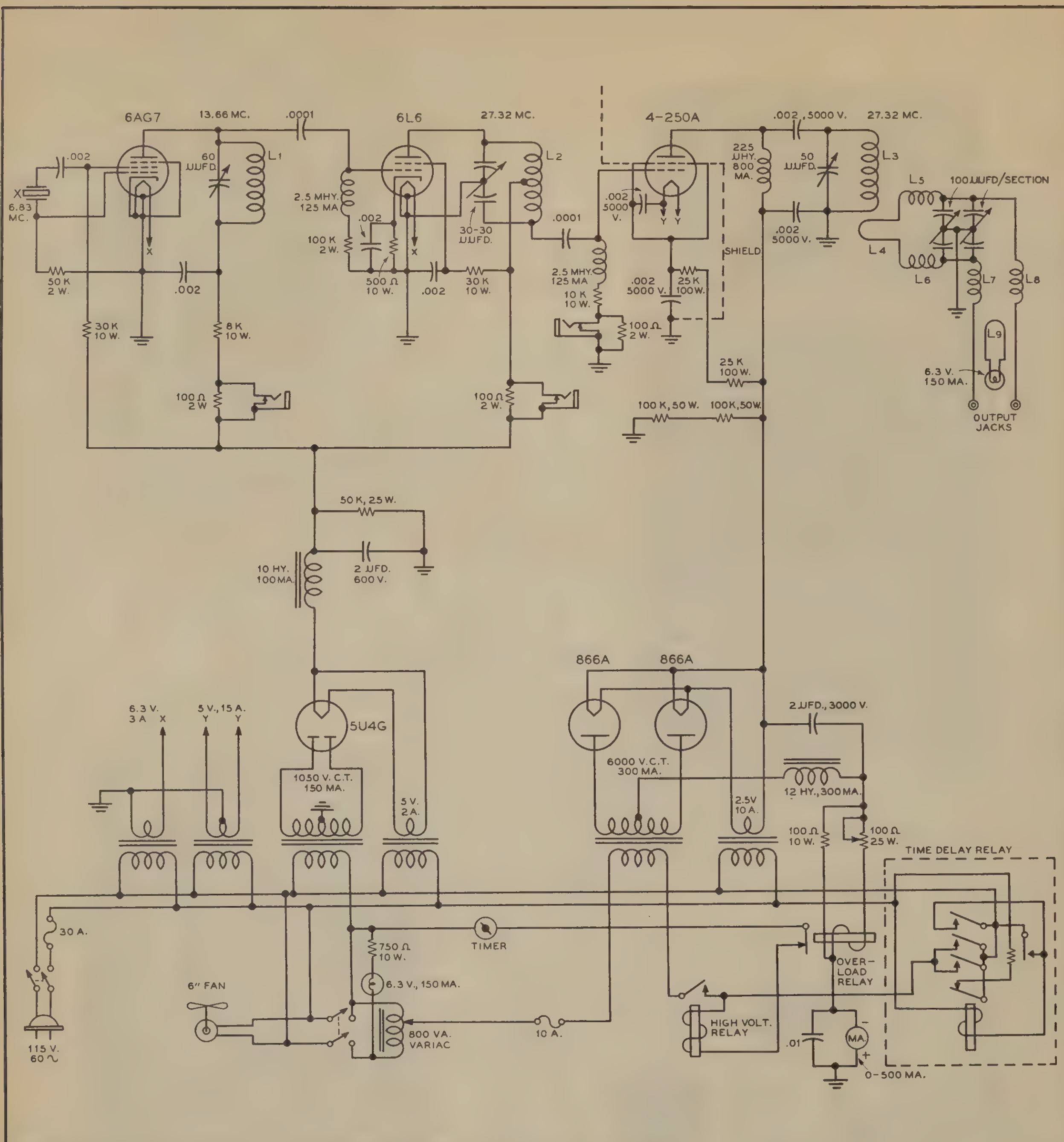


FIG. 4—Bottom view of the r-f section chassis. All r-f circuits preceeding the 4-250A plate circuit are placed under the chassis, to prevent unwanted feedback around the power amplifier stage. Holes in the 4-250A socket allow adequate circulation of air through the tube base, with the aid of the exhaust fan above the chassis.



CIRCUIT DIAGRAM OF THE CRYSTAL CONTROLLED DIATHERMY UNIT

(Figure 5)

PULSE

Eimac

TUBES

When, in 1936, government engineers first tried Eimac tubes as pulsed oscillators, radar became a reality in the United States. The ability of standard Eimac tube types to withstand voltages many times in excess of their maximum CW ratings and to deliver high orders of emission current over relatively long periods of time made possible the attainment of the high peak power required for a practical radar system.

Throughout the years since 1936, the development of improved pulse equipment has been paced by new Eimac tubes and the continual improvement of existing types for better and more reliable operation under pulsed conditions.

Important milestones in the use of Eimac tubes in pulse service are:

- Eimac 100T tubes used as pulsed VHF oscillators in the Navy's first radar tests at sea aboard the USS New York in 1938.
- Eimac VT-127's, a modification of the 100T used as oscillators and Eimac 304T's used as modulators in the SCR-268, one of the Army's first radar sets.
- Eimac 15E and 15R miniature transmitting tubes developed for and used as pulsed oscillators and high voltage rectifiers in ASB airborn search radar.
- Eimac 327A and 227A tubes developed for use as pulsed oscillators in Navy search radar sets of the SC and SK series.
- Eimac 527 tube developed for and used in SK-1M and SR radar for high-power search.
- Eimac 1000T, later modified for mass production and designated 6C21, used as modulator for the Armys famous SCR-584 radar.

During World War II Eimac produced nearly 2 million tubes of its own design for pulse service. In the process of developing and producing these tubes Eimac has gained "know how" about the pulse operation of tubes which is unequaled in the vacuum tube industry. This knowledge has made it possible to develop new tubes having outstanding characteristics for pulse operation. Among these tubes are oscillators and amplifiers capable of delivering pulse powers from a few tens of kilowatts to megawatts and modulators which will key currents from a few amperes to hundreds of amperes.

Years of experience have been gained regarding the pulse capabilities of standard Eimac types. Some of this information is presented on the following pages. However, many pulse applications are so specialized in nature that they do not lend themselves to general rules or tabular presentation. If your problem is of this sort, avail yourself of the services of the Eimac Field Engineering Department.

APPLICATION BULLETIN

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

NUMBER 3
PULSE SERVICE NOTES

REVISED 1-19-53

PULSE SERVICE NOTES

In pulse service, where the "on-time" is small compared to the "off-time," Eimac tubes with their ample reserve of filament emission and freedom from internal insulators can be run to a much higher peak-power than is permissible in continuous services. In continuous service, the published voltage and current maxima of Eimac tubes are generally set at values considerably less than the inherent limitations of the design, due to the need to consider the average power dissipated on the anode, grids, and entire tube structure. In pulse service, it is usually reasonable to increase the applied electrode voltages and resulting pulse currents above the maximum values shown for continuous service on the data sheets.

Because of the wide variety of operating conditions in pulse service, it seems advisable to indicate possibilities of tube performance rather than specific operating conditions. It is the user's responsibility to see that no basic limitations of the tubes are exceeded and to introduce factors of safety according to the needs of the particular application.

The principal basic limitations of the tube are given below:

1. **Average Electrode Dissipation.** The dissipation limits of the electrodes are given on the tube data sheet and usually under Radio Frequency Power Amplifier or Oscillator Service. The dissipation must be average over a full repeated pulse cycle. The length of the applied pulse must not be so great that the temperature rises excessively on any one pulse. Pulse times as high as 0.1 second are often not unreasonable. Above about 0.1 seconds the rise in temperature of the electrodes rather than the average power during the pulse becomes the basic limitation and this type of service is discussed under Item 5, "Long Pulse Operation."

   Usually, the average electrode dissipation is the product of the dissipation on the element during the on-time, multiplied by the duty cycle (ratio of on-time to a full cycle time). This assumes that the pulse is essentially a square wave. The dissipation may be considerably greater if intermediate values of current between zero and the maximum value flow for appreciable time. Sometimes uneven heating of an element may be a further limitation. In the case of a radiation-cooled anode, this effect is apparent and the temperature of the hottest spot should not be allowed to exceed the normal maximum anode temperature.

2. **Envelope and Seal Temperatures.** The temperature requirements of the bulb and seals will be met if the ordinary cooling instructions are followed. In continuous radio frequency service, a limiting upper frequency is usually specified above which operation at reduced ratings or increased cooling is recommended. In pulse service above this frequency, care should be taken to see that the heating of the leads due to rf charging currents will not be greater than normal.

3. **Available Cathode Emission.** In continuous service, the tube currents are usually limited by dissipation of the electrodes and for convenience are given in terms of dc components read on a meter external to the tube. In pulse service, one needs to know the available total cathode emission in order to engineer the application.

   With thoriated tungsten filaments operating at rated voltage in Eimac tubes, the available emission throughout life is above 80 milliamperes per watt of filament power. By raising the filament voltage 10%, this figure can be approximately doubled. Above 10%, the emission will not be further increased, except for short periods of time due to the failure to maintain the optimum emitting surface conditions.

   With oxide coated cathodes, the available peak emission is not clearly defined or as easily generalized as in the case of thoriated tungsten fila-

ments. It appears that the available emission for pulse work in typical oxide coated cathodes used in Eimac tubes can conservatively be estimated as 500 ma. per watt of heater power. This figure assumes that the pulse duration is not over about 3 micro-seconds. There is some evidence that above 3 micro-seconds, the maximum usable space current may have to be reduced.

4. VOLTAGE INSULATION. The breakdown voltage of Eimac tubes is usually well above the values given for continuous service. The basic limit is related to the maximum instantaneous voltage applied to the anode of the tube at any instant. It is also somewhat affected by the regulation of the supply voltage and length of time the voltage is applied. The accompanying table is a rough guide to the values of dc anode voltage that can be applied to the tube.

5. LONG PULSE OPERATION. When the length of the applied pulse exceeds about 0.1 seconds (100 milliseconds) the power limitation is no longer the average power dissipated on the electrodes and one must consider the temperature rise of the electrodes (principally the grid wires) during the time the pulse is on. If the pulse duration is in excess of 2.5 seconds the tube must be treated as in continuous service and the normal data sheet ratings apply.

The maximum capabilities of a thoriated tungsten tube in pulse service when the pulse duration is between 0.1 seconds and 2.5 seconds can be computed by using the accompanying curve and table.

As long as the off-time between pulses is 5 seconds or more the pulse may be repeated even though the maximum tube capability for a given pulse length is utilized. Because the grid dissipation is the principal limitation, the curve and table give factors to compute the permissible grid dissipation during the pulse. The product of the two factors is the number of times the rated grid dissipation can be exceeded for a given pulse duration. The factor from the curve is to be used directly for the plate and screen dissipation.

When first running up the voltage on a tube in pulse service, or after the tube has been idle for some time occasional internal flash breakdowns in a tube are to be expected. The circuit should be designed so that the high rush of current and resulting high transient voltage surges will not be destructive to equipment. The transients, due to momentary breakdown of the insulation of the vacuum space, have very high frequency components. As a consequence, high voltages will develop across small lead inductances. Spark gaps, bypass capacitors and inductance filters are often used to dissipate or divert this energy into harmless channels.

Protective devices should be designed to remove the applied voltage quickly when a breakdown occurs. If overload protective action is fast, and the regulation of the source voltage poor enough, no damage to the tube will result and operation can be resumed.

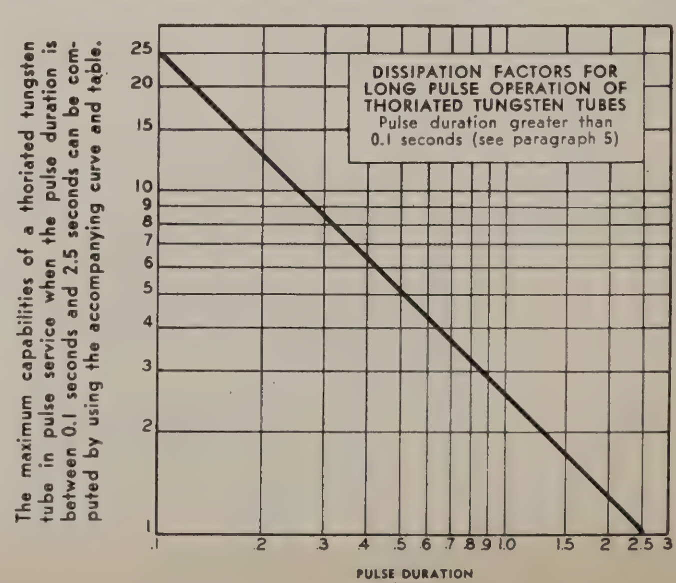
No guarantee is made that the tube will not break down at the voltages given on the chart. It is estimated from considerable experience that these are approximately safe maximum values to be considered in design work.

▶ Indicates Revision

MAXIMUM RATINGS FOR PULSED SERVICE

Tube Type	MAXIMUM PLATE VOLTAGE			Max. Screen Voltage Kilovolts	Grid Factor Long Pulse Operation*
	RF Service Plate Pulsed Kilovolts	RF Service Grid Pulsed Kilovolts	Pulse Modulator Service Kilovolts		
▶ 2C39A	3.5	....	....	....	....
3C24	10	7.5	15	....	.68
3X2500A3	15	10	25	....	.68
3X2500F3	15	10	25	....	.68
▶ 3W5000A3	15	10	25	....	.68
▶ 3W5000F3	15	10	25	....	.68
4E27A/5-125B	12	9	18	2.0	1.68
4-65A	10	7.5	15	2.0	.57
4-125A	12	9	18	2.0	1.87
4-250A	15	10	20	2.5	2.7
4-400A	15	10	20	2.5	2.7
4-1000A	20	15	30	2.5	1.54
4PR60A	....	....	20	1.5	....
4X150A	2	....	3	1.0	....
▶ 4X150D	2	....	3	1.0	....
4X150G	2	....	3	1.0	....
4X500A	10	7.5	15	2.0	.95
4X500F	10	7.5	15	2.0	.95
6C21	20	15	30	....	....
15E	12.5	10	15	....	....
25T	10	7.5	15	....	.77
35T	10	7.5	15	....	.84
35TG	10	7.5	15	....	.84
UH-50	5	4	7.5	....	....
75TH	12	9	17	....	.67
75TL	12	9	17	....	.62
100TH	15	10	20	....	1.01
100TL	15	10	20	....	1.11
152TH	12	9	18	....	.71
152TL	12	9	18	....	.65
250TH	18	15	25	....	1.03
250TL	18	15	25	....	.89
304TH	12	9	18	....	.71
304TL	12	9	18	....	.65
327A	20	15	30	....	....
450TH	20	15	30	....	1.09
450TL	20	15	30	....	1.0
527	20	18	30	....	....
592/3-200A3	18	15	25	....	.80
750TL	20	15	30	....	1.09
1000T	20	15	30	....	1.1
1500T	20	15	30	....	1.61
2000T	20	15	30	....	1.8

*Combine with factor taken from curve for various pulse duration times.



APPLICATION BULLETIN

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

NUMBER 4
CLASS C AMPLIFIER CALCULATIONS

CLASS C AMPLIFIER CALCULATIONS WITH THE AID OF CONSTANT CURRENT CHARACTERISTICS

In calculating and predicting the operation of a vacuum tube as a class-C radio frequency amplifier, the considerations which determine the operating conditions are plate efficiency, power output required, maximum allowable grid and plate dissipation, maximum allowable plate voltage and maximum allowable plate current. The values chosen for these factors will depend both on the demands of a particular application and the tube selected to do the job.

The plate and grid currents of a class-C amplifier are periodic pulses, the durations of which are always less than 180 degrees. For this reason the average plate and grid currents, power output, driving power, etc., cannot be directly calculated but must be determined by a Fourier analysis from points selected along the line of operation as plotted on the constant-current characteristics. This may be done either analytically or graphically. While the Fourier analysis has the advantage of accuracy, it also has the disadvantage of being tedious and involved.

An approximate analysis which has proven to be sufficiently accurate for most purposes is presented in the following material. This system has the advantage of giving the desired information at the first trial. The system, which is an adaption of a method developed by Wagener[1], is direct because the important factors, power output, plate efficiency and plate voltage may be arbitrarily selected at the beginning.

In the material which follows, the following set of symbols will be used. These symbols are illustrated graphically in Figure 1.

Symbols

P_i = Plate power input
P_o = Plate power output
P_p = Plate dissipation
n = Plate efficiency expressed as a decimal
E_{bb} = D-c plate supply voltage
E_{pm} = Peak fundamental plate voltage
e_{bmin} = Minimum instantaneous plate votage
I_b = Average plate current
I_{pm} = Peak fundamental plate current
i_{bmax} = Maximum instantaneous plate current
θ_p = One-half angle of plate current flow
E_{cc} = D-c grid bias voltage (a negative quantity)
E_{c2} = D-c screen voltage
E_{gm} = Peak fundamental grid excitation voltage
e_{cmp} = Maximum positive instantaneous grid voltage
I_c = Average grid current
i_{cmax} = Maximum instantaneous grid current
P_d = Grid driving power (including both grid and bias losses)
P_g = Grid dissipation
μ = Amplification factor of triode
μ_{12} = Grid-screen amplification factor of tetrode

[1] W. G. Wagener "Simplified Methods for Computing Performance of Transmitting Tubes," **Proc. I.R.E.**, Vol. 25, p. 47, (Jan. 1937).

(Reprinted from the Eimac News Industrial Edition, March 1945)

Indicates Revision 11-10-49

Method

The first step in the use of the system to be described is to determine the power which must be delivered by the class-C amplifier. In making this determination it is well to remember that ordinarily from 5 to 10 per cent of the power delivered by the amplifier tube or tubes will be lost in well-designed tank and coupling circuits at frequencies below 20 Mc. Above 20 Mc. the tank and coupling circuit losses are ordinarily somewhat above 10 per cent.

The plate power input necessary to produce the required output is determined by the plate efficiency:

$$P_i = \frac{P_o}{n}$$

For most applications it is desirable to operate at the highest possible efficiency. High-efficiency operation usually requires less expensive tubes and power supplies, and the amount of artificial cooling needed is frequently less than for low-efficiency operation. On the other hand, high-efficiency operation often requires more driving power and higher operating plate voltages. Eimac triodes and tetrodes will operate satisfactorily at 80 per cent efficiency at the highest recommended plate voltages and at 75 per cent efficiency at medium plate voltages.

The first determining factor in selecting a tube or tubes for any particular application is the maximum allowable plate dissipation. The total plate dissipation rating for the number of tubes used must be equal to or greater than that calculated from

$$P_p = P_i - P_o$$

After selecting a tube or tubes to meet the power output and plate dissipation requirements it becomes necessary to determine from the tube characteristics whether the tube selected is capable of the required operation and, if so, to determine the driving power, grid bias and grid current.

The complete procedure necessary to determine the class-C-amplifier operating conditions is as follows[2]:

1. Select plate voltage, power output and efficiency.
2. Determine plate input from

$$P_i = \frac{P_o}{n}$$

3. Determine plate dissipation from

$$P_p = P_i - P_o$$

P_p must not exceed maximum rated plate dissipation for tube or tubes selected.

4. Determine average plate current from

$$I_b = \frac{P_i}{E_{bb}}$$

I_b must not exceed maximum rated plate current for tube selected.

5. Determine approximate i_{bmax} from

$$i_{bmax} = 4.5\, I_b \text{ for } n = 0.80$$
$$i_{bmax} = 4.0\, I_b \text{ for } n = 0.75$$
$$i_{bmax} = 3.5\, I_b \text{ for } n = 0.70$$

6. Locate the point on constant-current characteristics where the constant plate current line corresponding to the approximate i_{bmax} determined in step 5 crosses the line of equal plate and grid voltages ("diode line") in the case of triodes; or in the case of tetrodes where the plate current line turns rapidly upward. Read e_{bmin} at this point.[3]
7. Calculate E_{pm} from

$$E_{pm} = E_{bb} - e_{bmin}$$

8. Calculate the ratio $\frac{I_{pm}}{I_b}$ from

$$\frac{I_{pm}}{I_b} = \frac{2n\, E_{bb}}{E_{pm}}$$

9. From the ratio of $\frac{I_{pm}}{I_b}$ calculated in step 8 determine the ratio $\frac{i_{bmax}}{I_b}$ from Chart 1.
10. Calculate a new value for i_{bmax} from ratio found in step 9.

$$i_{bmax} = (\text{ratio from step 9})\, I_b$$

11. Read e_{cmp} and i_{cmax} from constant current characteristics for values of e_{bmin} and i_{bmax} determined in steps 6 and 10.
12. Calculate the cosine of one-half the angle of plate current flow from

$$\cos \theta_p = 2.3 \left(\frac{I_{pm}}{I_b} - 1.57 \right) \quad {}^4$$

13. Calculate the grid bias voltage from

$$E_{cc} = \frac{1}{1 - \cos \theta_p} \left[\cos \theta_p \left(\frac{E_{pm}}{\mu} - e_{cmp} \right) - \frac{E_{bb}}{\mu} \right], \text{ for triodes;}$$

or $$E_{cc} = \frac{1}{1 - \cos \theta_p} \left[- e_{cmp} \cos\theta - \frac{E_{c2}}{\mu_{12}} \right], \text{ for tetrodes.}$$

14. Calculate the peak fundamental grid excitation voltage from

$$E_{gm} = e_{cmp} - E_{cc}$$

15. Calculate the ratio $\frac{E_{gm}}{E_{cc}}$ for values of E_{cc} and E_{gm} found in steps 13 and 14.
16. Read ratio $\frac{i_{cmax}}{I_c}$ from Chart 2 for ratio $\frac{E_{gm}}{E_{cc}}$ found in step 15.
17. Calculate average grid current from ratio found in step 16 and value of i_{cmax} found in step 11.

$$I_c = \frac{i_{cmax}}{\text{ratio from step 16}}$$

18. Calculate approximate grid driving power from

$$P_d = 0.9\, E_{gm} I_c \quad {}^5$$

19. Determine grid dissipation from

$$P_g = P_d + E_{cc} I_c$$

P_g must not exceed the maximum rated grid dissipation for the tube selected.

Example

A typical application of this procedure is shown in the example below.

1. Desired power output.............. 1250 watts
   Desired plate voltage.............. 4000 volts
   Desired plate efficiency.......... 75 per cent (n=0.75)
2. $$P_i = \frac{1250}{0.75} = 1670 \text{ watts}$$
3. $$P_p = 1670 - 1250 = 420 \text{ watts}$$

   Try type 450TL; Max. P_p = 450W; μ = 18
4. $$I_b = \frac{1670}{4000} = 0.417 \text{ ampere}$$

   (Max. I_b for 450TL = 0.600 ampere)
5. Approximate $i_{bmax} = 4.0 \times 0.417 = 1.67$ ampere
6. e_{bmin} = 315 volts (see figure 2)
7. $E_{pm} = 4000 - 315 = 3685$ volts
8. $$\frac{I_{pm}}{I_b} = \frac{2 \times 0.75 \times 4000}{3685} = 1.63$$
9. $$\frac{i_{bmax}}{I_b} = 3.45 \text{ (from Chart 1)}$$
10. $i_{bmax} = 3.45 \times 0.417 = 1.44$ amperes
11. $e_{cmp} = 280$ volts

    $i_{cmax} = 0.330$ amperes (see figure 3)
12. $\cos \theta_p = 2.32\ (1.63 - 1.57) = 0.139$
13. $$E_{cc} = \frac{1}{1 - 0.139} \left[0.139 \left(\frac{3685}{18} - 280 \right) - \frac{4000}{18} \right] = -270 \text{ volts}$$
14. $E_{gm} = 280 - (-270) = 550$ volts
15. $$\frac{E_{gm}}{E_{cc}} = \frac{550}{-270} = -2.04$$
16. $$\frac{i_{cmax}}{I_c} = 5.69 \text{ (from Chart 2)}$$
17. $$I_c = \frac{0.330}{5.69} = 0.058 \text{ amperes}$$
18. $P_d = 0.9 \times 550 \times 0.058 = 28.7$ watts
19. $P_g = 28.7 + (-270 \times 0.058) = 13.0$ watts

    (Max P_g for 450TL = 65 watts)[6]

2 In the case of push-pull or parallel amplifier tubes the analysis should be carried out on the basis of a single tube, dividing P_i, P_o and P_p by the number of tubes before starting the analysis and multiplying I_b, I_c and P_d by the same factor after completing the analysis.

3 In a few cases the lines of constant plate current will inflect sharply upward before reaching the diode line. In these cases e_{bmin} should not be read at the diode line but at the point where the plate current line intersects a line drawn from the origin through these points of inflection.

Indicates Revision 11-10-49

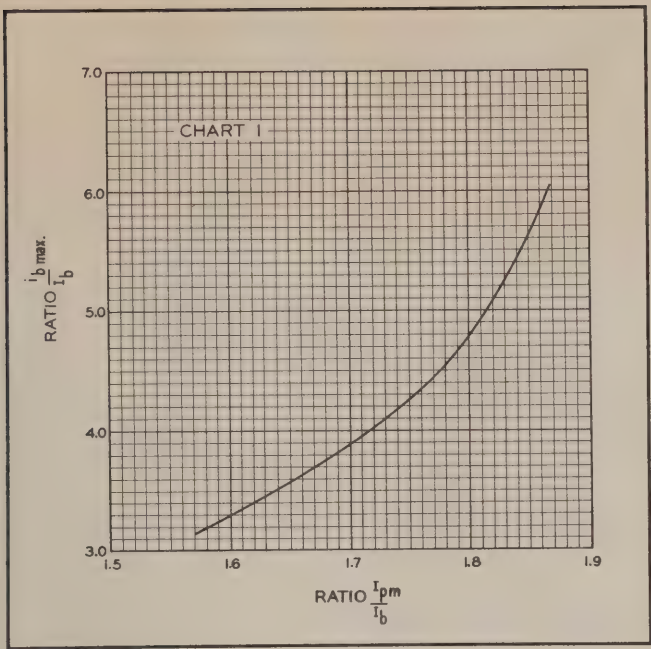


Chart 1

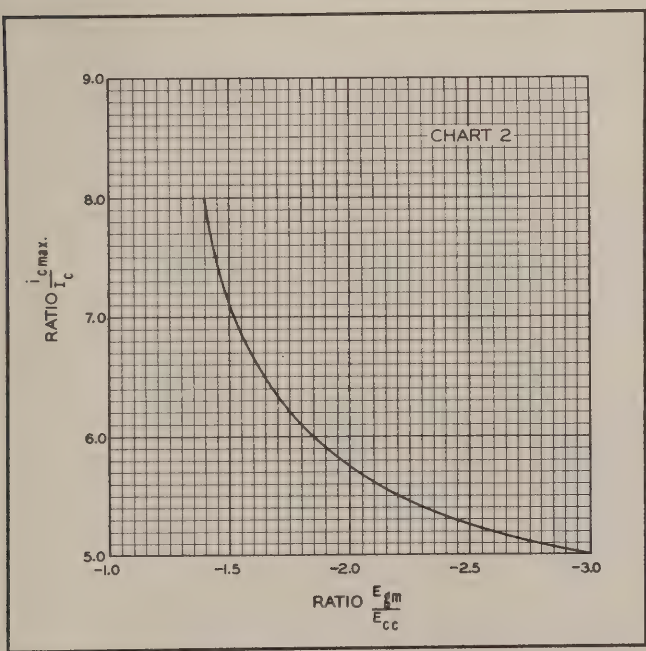


Chart 2

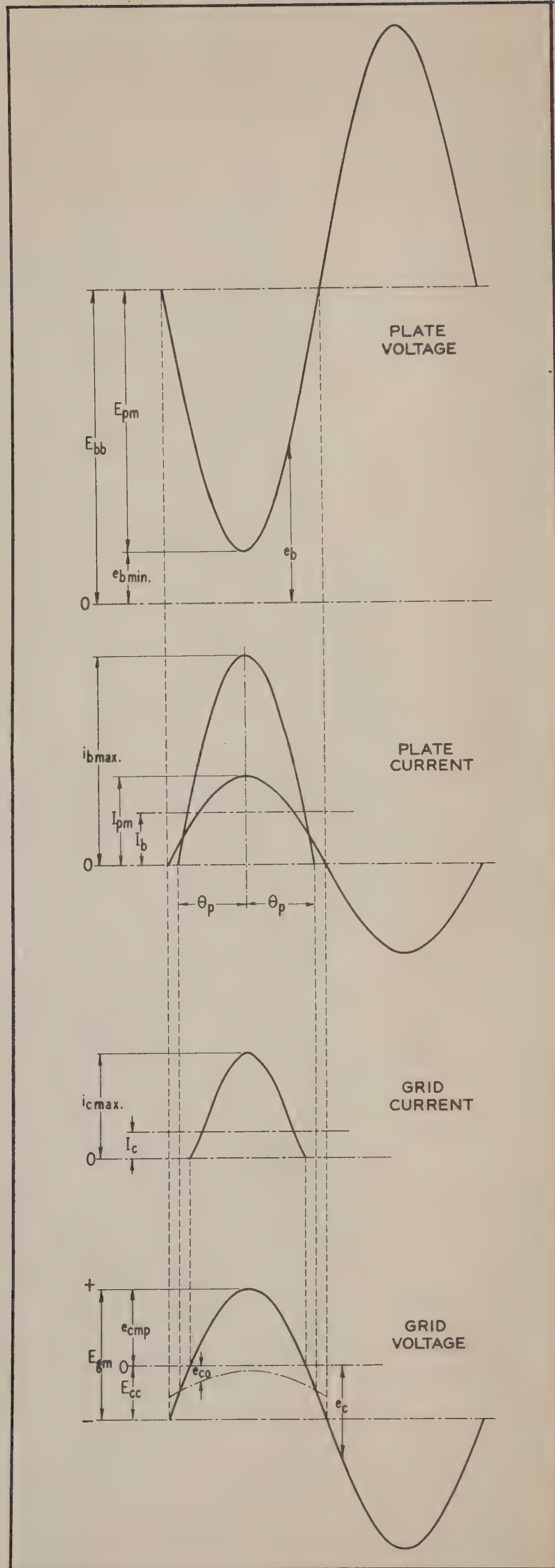


Figure 1. Symbols

4 If this calculation gives Cos θ_p as zero or a negative quantity class-B operation is indicated and new operating conditions should be chosen on a basis of higher efficiency (less plate dissipation, more power output or less power input).

5 The calculated driving power is that actually used in supplying the grid and bias losses. Suitable allowance in driver design must be made to allow for losses in the coupling circuits between the driver plate and the amplifier grid.

6 "Vacuum Tube Ratings" Eimac News, Industrial Edition, Jan. 1945.

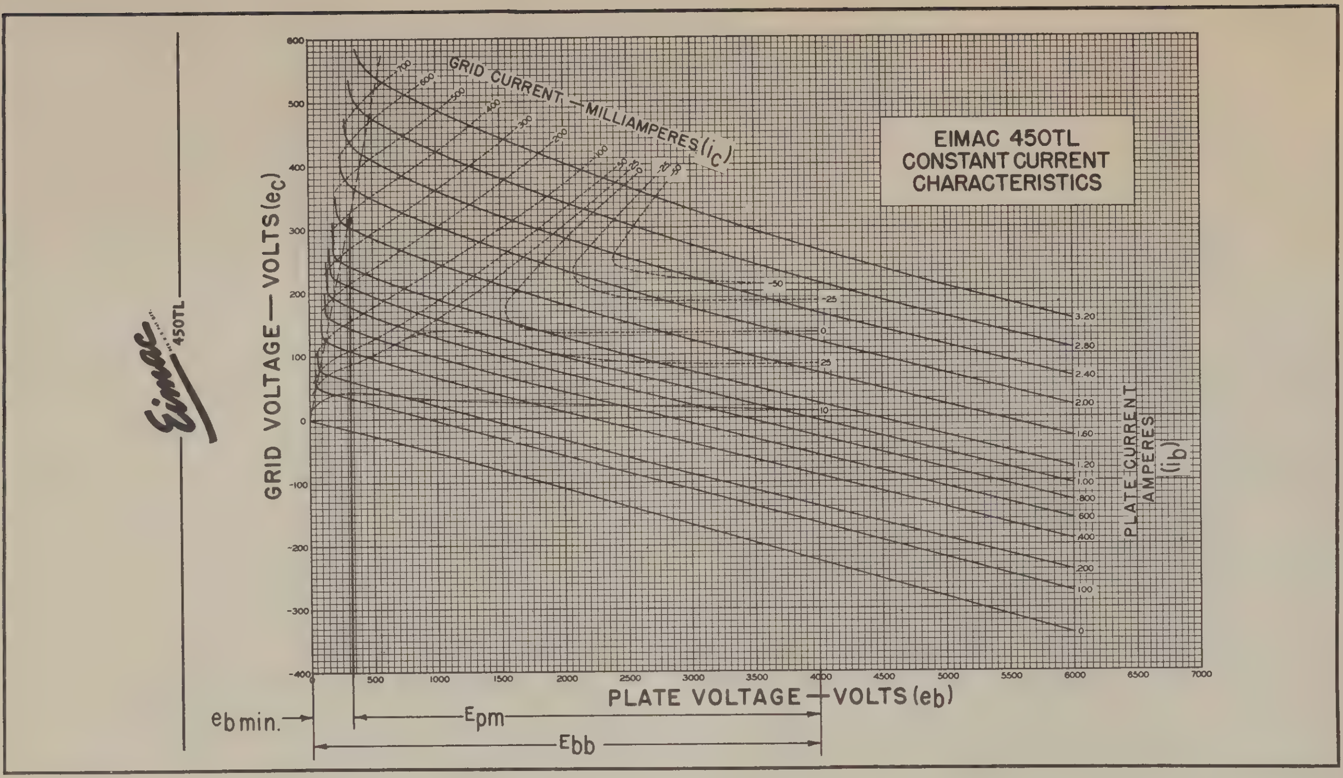


Figure 2. 450TL constant-current characteristics showing method of determining e_{bmin} and E_{pm} in steps 6 and 7 from value of i_b obtained in step 5.

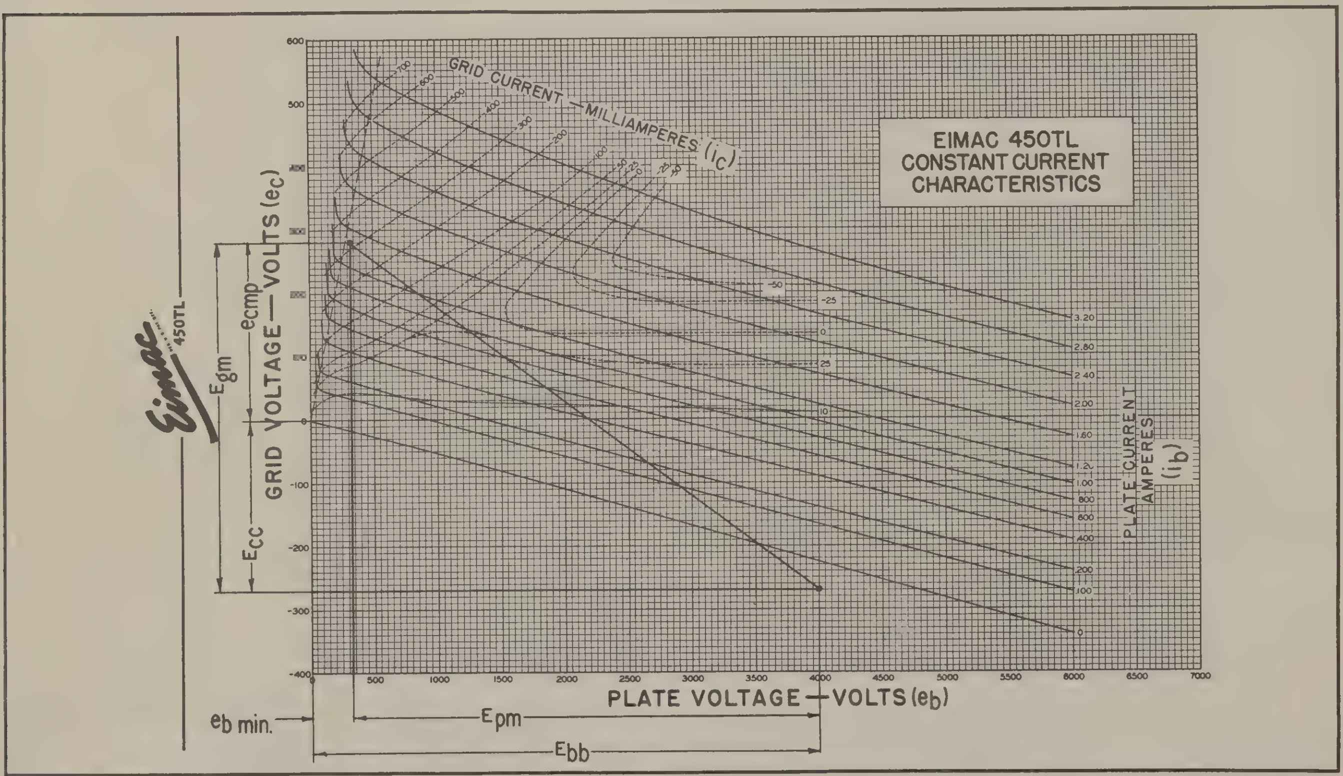


Figure 3. Method of determining e_{cmp} and i_c on 450TL constant-current characteristics from values of e_{bmin} and E_{pm} found in steps 6 and 7 and value of i_b found in step 10. The value of E_{cc} and E_{gm} from steps 13 and 14 and the operating line are also shown.

APPLICATION BULLETIN

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

NUMBER 5

TUBE PERFORMANCE COMPUTOR

DETAILED INSTRUCTIONS

TUBE PERFORMANCE COMPUTOR FOR RF AMPLIFIERS (CLASS B, C, AND FREQUENCY MULTIPLIERS)

It is quite easy to make a close estimate of the performance of a vacuum tube in radio frequency power amplifier service, or an approximation in the case of harmonic amplifier service. Such estimates will give RF output power, DC input power, grid driving power and all DC current values.

These estimates can be made easily by using the Eimac Tube Performance Computor and the characteristic curves of a tube, plotted on plate voltage/grid voltage curves (constant current curves). Only the ability to multiply out figures taken from the curves by means of the computor is required.

By graphically laying out the trace of the plate and grid voltages as they rise and fall about the applied DC plate voltage and DC grid bias a clearer understanding is possible of the action taking place within a tube. With such an understanding the operating conditions can be altered readily to suit one's particular requirements.

Simple Action in Class C RF Amplifiers

In an amplifier a varying voltage is applied to the control grid of the tube. Simultaneously the plate voltage will vary in a similar manner, due to the action of the amplified current flowing in the plate circuit. In radio frequency applications with resonant circuits these voltage variations are smooth sine wave variations, 180° out of phase (as the grid voltage rises and becomes *more* positive, the plate voltage falls and becomes *less* positive) as indicated in Fig. 1. Note how these variations center about the DC plate voltage and the DC control grid bias.

Let us now see how such variations of the plate and grid voltages of a tube appear on the constant current curve sheet of a tube. In Fig. 2 these variations have been indicated next to the plate voltage and grid voltage scales of a typical constant current curve. At some instant of time, shown as "t" on the time scales, the grid voltage has a value which is the point marked "eg" on the grid voltage sine wave. At this same instant of time the plate voltage has a value which is the point "ep" marked on the plate voltage sine wave. If now one finds the point on the tube curve sheet corresponding to these values (where a line drawn from "eg" and a line drawn from "ep" cross) he will be at point A in Fig. 2. As the values of grid voltage "eg" and plate voltage "ep" vary over the RF cycle, the point A moves up and down a line, which in the case of the normal RF power amplifier is a straight line. This line is called the "Operating Line."

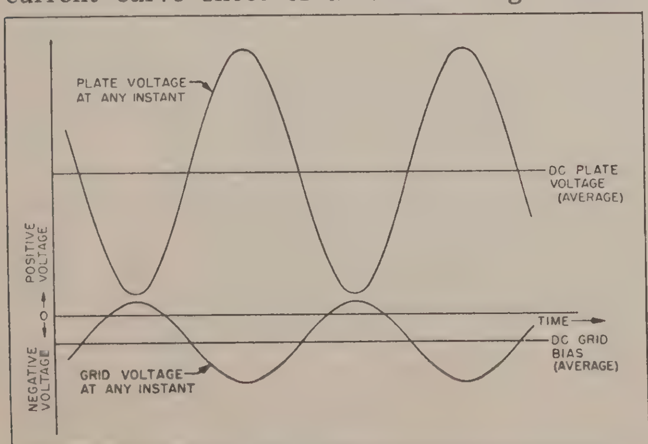


Figure 1

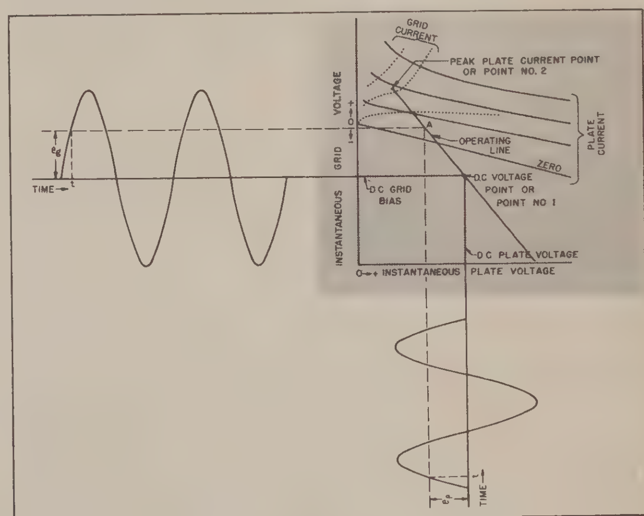


Figure 2

Any point on the operating line (when drawn on a curve sheet as in Fig. 2 or Fig. 4) tells the instantaneous values of plate current, screen current, and grid current which must flow when those particular values of grid and plate voltage are applied to the tube. Thus by reading off the values of the currents and plotting them against the time, t, one can obtain a curve of instantaneous values of plate and grid current. See Fig. 3.

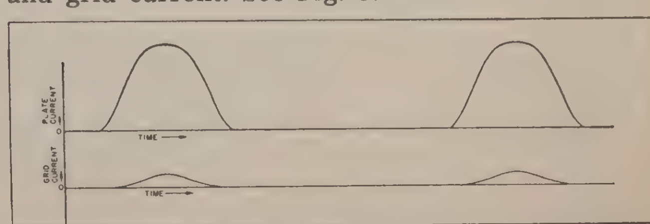


Figure 3

If we analyze the plate and grid current values shown, we can predict that they will cause a DC ammeter to show a particular reading. This is called the DC component of the current. Also, we can predict that if the plate current flows through a properly loaded resonant RF circuit a certain amount of radio frequency power will be delivered to that circuit. If the circuit is tuned to the fundamental frequency (same frequency as the RF grid voltage) the power delivered will be due to the fundamental (or principle radio frequency) component of plate current. If the circuit is tuned to a harmonic of the grid voltage frequency (for instance, two, or three times the frequency) the power delivered will be due to a harmonic component of the plate current.

The Eimac Tube Performance Computor gives us the means to make these simple calculations. It is a means with which to determine the DC component, the fundamental RF component, or the approximate harmonic component of the current flowing in a tube when the tube is operating as a radio frequency amplifier, and enables one to state what all meter readings will be and to predict the RF output power and the required driving power. With these factors known we are then able also to forecast what will happen if any of the operating conditions are changed.

Use of the Eimac Tube Performance Computor

The Eimac Tube Performance Computor is a simple aid to enable one to select suitable values from the characteristic curves of a tube, and by means of simple calculations to forecast the performance of the tube in radio frequency power amplifiers.

The basic steps are outlined under "Instructions" on the computor. This requires selecting DC plate and grid bias voltages, being guided by the typical operating values given on the technical data sheet for the tube type and by general experience. Next, a suitable "Operating Line" must be chosen on the constant current curves for the tube type (plotted on grid voltage/plate voltage scales).

The computor when properly placed over this operating line enables one to obtain instantaneous values of the currents flowing at every 15° of the electrical cycle. The formulas given on the computor were derived by Chaffee[1] to give the various average and harmonic components of the resulting currents. Knowing these current component values and the radio frequency voltage values which are indicated by the use of the computor, one can readily calculate the complete performance of the tube.

The fundamental methods of making such computations, and the considerations necessary to stay within ratings of the tube types, and accomplish various forms of modulation have been covered in the literature.[2,3,4,5,6,7] The method for the case of harmonic amplifier service is approximate and should be used only for tetrode and pentode tubes, where the plate voltage has little effect on the amount of plate current flowing. A more exact method, showing that for harmonic operation the operating line is a simple Lissajou figure, has been described by Brown.[8]

The results of using this computor for power amplifier service can be applied in combination with the other methods given in the literature to give good accuracy with simpler procedues. The resulting accuracy is well within the normal variation of tube characteristics due to the normal variation in manufacturing dimensions of a tube. Since the published tube curves are only typical of the characteristics to be expected from a particular tube type, the calculated performance is well within the values expected when different tubes of a given tube type are operated under the assumed conditions.

Example Showing Detailed Use of the Eimac Tube Performance Computor

Radio Frequency Power Amplifier, Class C (Telegraphy or FM)

Let us say we have an Eimac 4-65A tetrode and want to make it work effectively. Also let us say we have a 2000 volt DC plate power supply available.

Within frequency limits, we know a tube should be able to run in class-C amplifier service with about 75% efficiency, or, in other words, to convert 75% of the DC plate input power into RF output power. The difference, or 25% of the input power, is dissipated or lost as heat on the plate of the tube. The DC plate input power is then about four times the power dissipated on the plate.

The 4-65A tetrode has a maximum rated plate dissipation of 65 watts, so, to illustrate performance near the maximum rating, we'll choose an input power four times the plate dissipation, or 260 watts per tube. At 2000 volts the plate current per tube must then be 130 ma. It is usual practice, in the case of tetrodes and the medium or low mu triodes in class-C amplifier service for the DC grid bias voltage to be roughly two or three times the grid voltage necessary to cut off the flow of plate current. By referring to the curves of the 4-65A we decide to use a DC grid bias voltage of—120 volts.

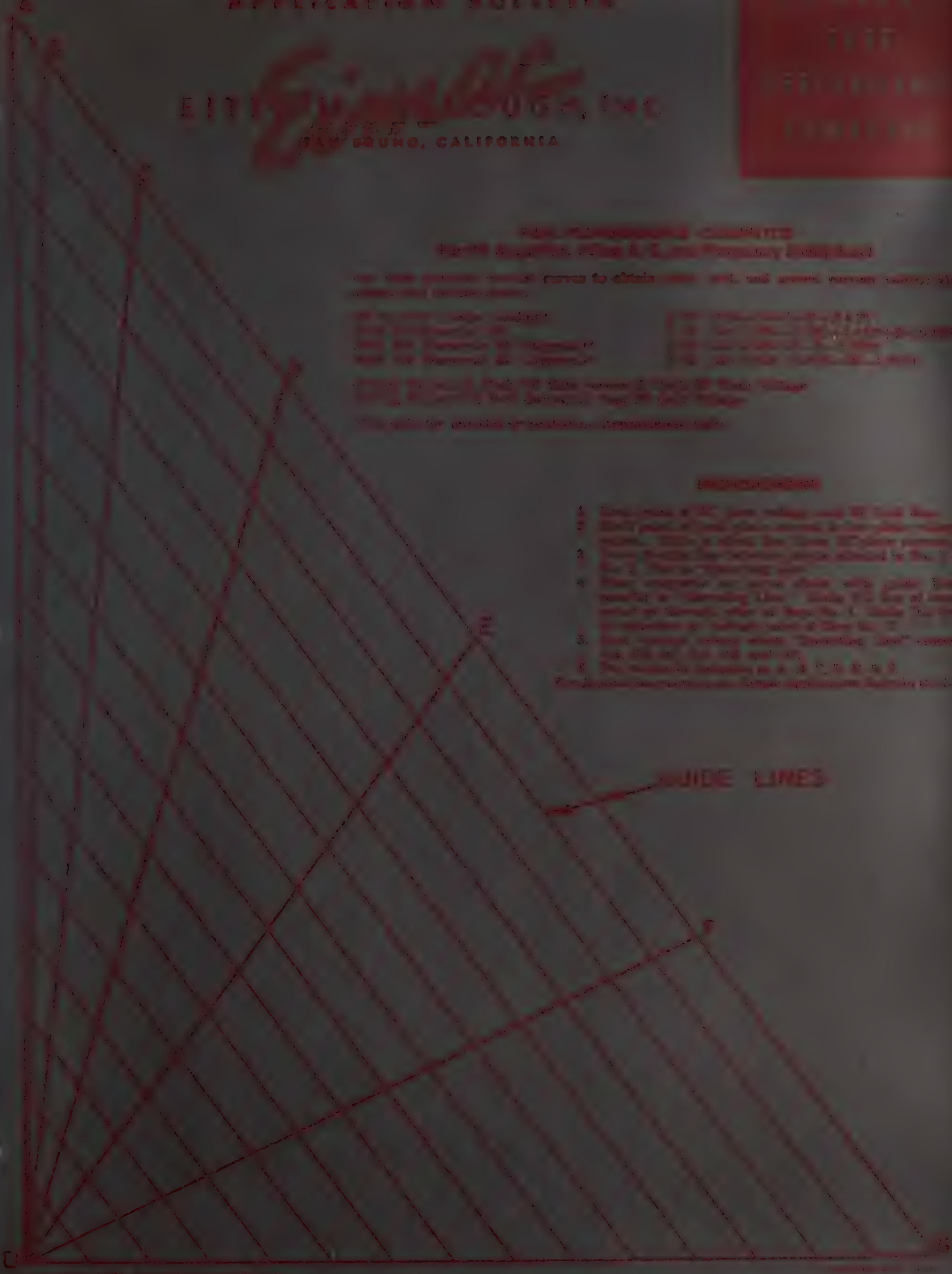
Let us now locate the "Operating Line" on the constant current curves of the 4-65A. See Fig. 4. First mark the point where the DC grid bias and DC plate voltage cross. The "Operating Line" must go through this point. Call it point No. 1. Next, we must decide what the peak value of plate current of the tube must be and how low we can let the instantaneous value of plate voltage go when the tube is passing this much current. This is necessary in order to locate the other end of the "Operating Line," point No. 2.

The peak value of plate current usually runs about four times the DC plate current. The minimum value of instantaneous plate voltage is usually set by the fact that if the voltage is too low the grid and screen currents will be needlessly high, and also little will be gained as far as output power is concerned. The minimum value of plate voltage is usually in the region where the plate constant current curves bend upward. See Fig.

APPLICATION BULLETIN

Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA



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curves to obtain [illegible]

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TUBE PERFORMANCE COMPUTOR

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

TUBE PERFORMANCE COMPUTOR
For RF Amplifiers (Class B, C, and Frequency Multipliers)

Use with constant current curves to obtain plate, grid, and screen current values; also output and driving power.

DC Current (meter reading)	1/12 (0.5A+B+C+D+E+F)
Peak Fundamental RF	1/12 (A+1.93B+1.73C+1.41D+E+0.52F)
Peak 2nd Harmonic RF (Approx.)*	1/12 (A+1.73B+C−E−1.73F)
Peak 3rd Harmonic RF (Approx.)*	1/12 (A+1.41B−1.41D−2E−1.41F)

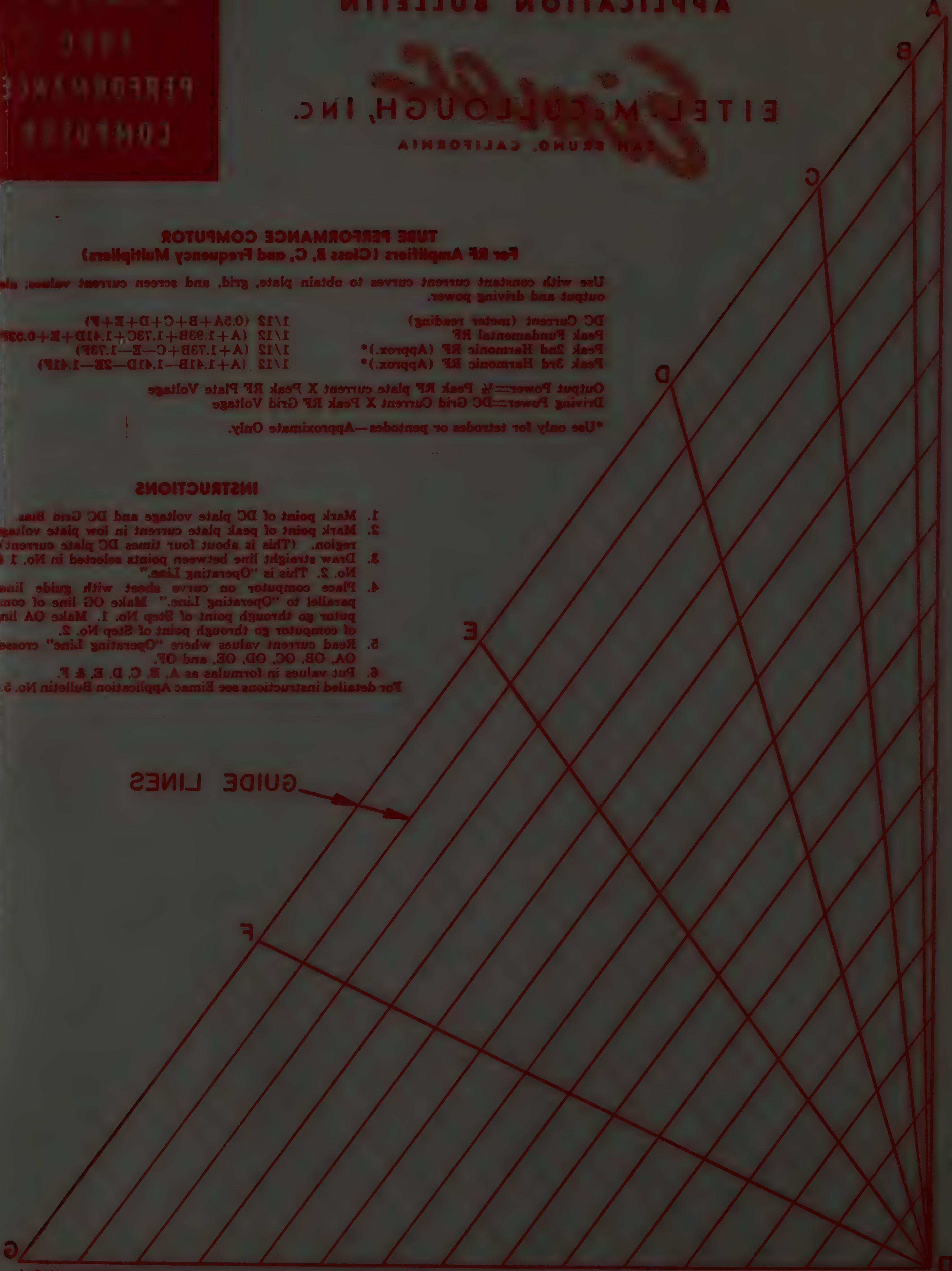
Output Power=½ Peak RF plate current X Peak RF Plate Voltage
Driving Power=DC Grid Current X Peak RF Grid Voltage

*Use only for tetrodes or pentodes—Approximate Only.

INSTRUCTIONS

1. Mark point of DC plate voltage and DC Grid Bias.
2. Mark point of peak plate current in low plate voltage region. (This is about four times DC plate current)
3. Draw straight line between points selected in No. 1 & No. 2. This is "Operating Line."
4. Place computor on curve sheet with guide lines parallel to "Operating Line." Make OG line of computor go through point of Step No. 1. Make OA line of computor go through point of Step No. 2.
5. Read current values where "Operating Line" crosses OA, OB, OC, OD, OE, and OF.
6. Put values in formulas as A, B, C, D, E, & F.

For detailed instructions see Eimac Application Bulletin No. 5.



4. (In the case of the triode this is near the "diode line" or line where the instantaneous grid and plate voltages are equal.) The practical procedure in calculating tube performance is to arbitrarily choose point No. 2 and complete the calculations. Then try other locations of point No. 2, complete the calculations, and compare the results.

In the case of the 4-65A let us choose a peak value of plate current about four times the DC plate current of 130 ma, or 500 ma. Let us choose a minimum instantaneous plate voltage of 250 volts and thus fix the upper end of the "Operating Line." Next, locate this point on the tube curves. This is point No. 2 on Fig. 4. (The plate currents which flow at various combinations of plate and grid voltages are shown by the plate current lines. The value of current for each line is noted. In-between values can be estimated closely enough for our purposes.) Now draw a straight line between points No. 1 and No. 2. This line is the "Operating Line" and shows the current and voltage values for each part of the RF cycle when current is being taken from the tube. (The non-conducting half of the RF cycle would be shown by extending this line an equal distance on the opposite side of point No. 1. However, there is little use in so doing because no current flows during this half of the cycle.)

The Eimac Tube Performance Computor can now be used to obtain the meter readings and power values from this "Operating Line." Place the computor on the constant current curve sheet so that the "guide lines" of the computor are parallel with the operating line. Now slide the computor about without turning it until the line OG passes through the DC voltage point No. 1 and line OA passes through the peak current point No. 2. *Make sure the guide lines are still parallel to the "Operating Line."*

Note that the lines OB, OC, OD, OE and OF of the computor all cross over the "Operating Line."

At each point where the lines OA, OB, etc., cross the "Operating Line" we need to determine the instantaneous values of plate current and grid current (and screen current if a tetrode or pentode is used) which is flowing at that particular moment in the RF cycle. Later, from these key values of current, we will calculate the values of DC plate current and grid current (and screen current) as well as the RF components of the plate current.

At each of these points, where the instantaneous current values are to be determined, a mark should be made on the constant current curve sheet of the tube. By noting where this mark lies with respect to the plate current curves, one can estimate the value of plate current flowing at this part of the cycle. Next, the location of this mark with respect to the control grid curves is noted and a value of grid current is estimated. Finally, by referring the mark to the screen grid curves, if the tube is a tetrode or pentode, a value of screen current is noted. These current values should be listed for each

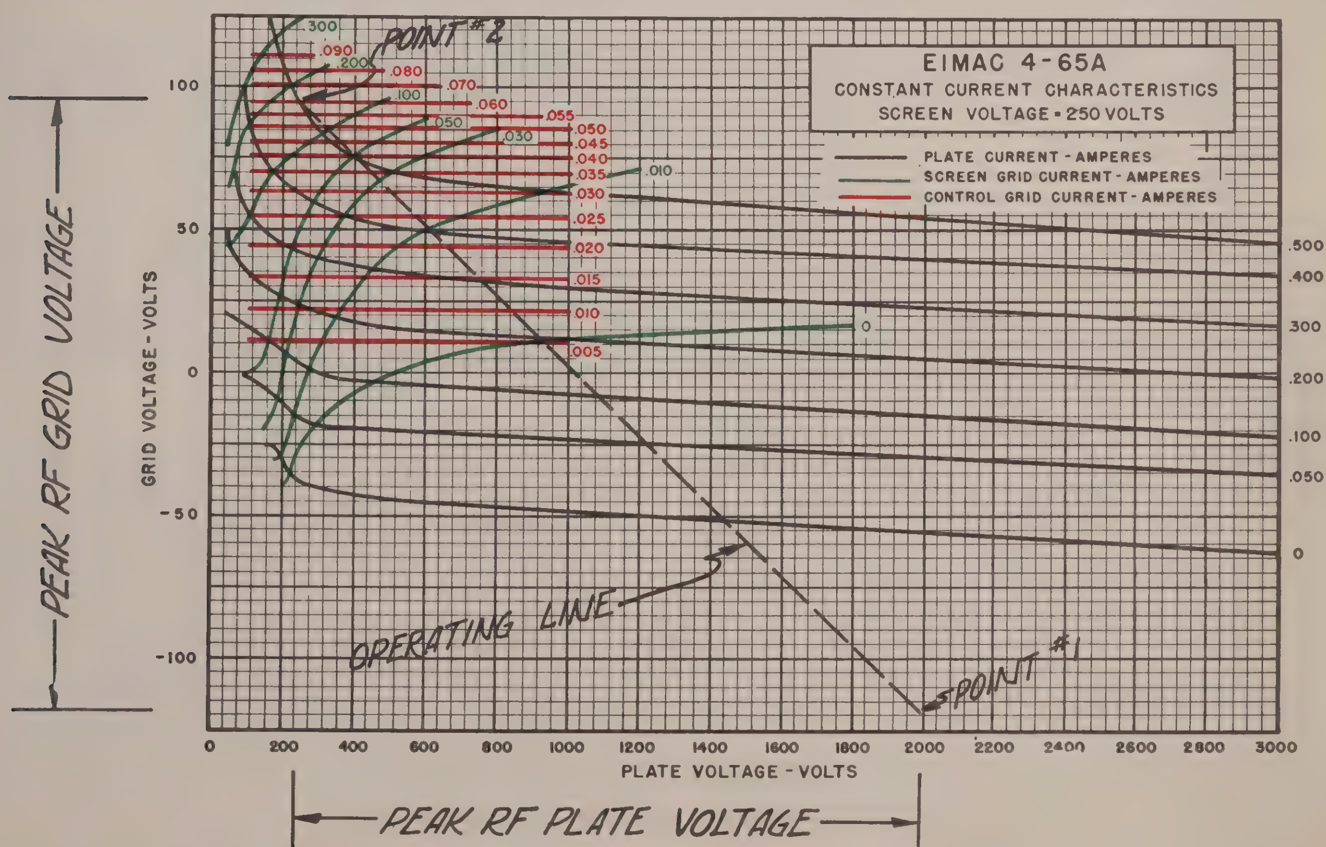


Figure 4

point where the lines OA, OB, etc., cross the operating line so that they can be combined later to calculate the various tube currents. At points where OF and OE cross, the current values are often zero.

Now in the example chosen, let us read off the instantaneous plate current values where these lines cross the "Operating Line." At the point where the line OA crosses the "Operating Line" the plate current is 500 ma. Where OB crosses the operating line the plate current can be estimated as 510 ma since the point is about 1/10 of the way from the 500 ma line to the 600 ma line. At OC the plate current is 460 ma, OD 290 ma, OE 75 ma, OF and OG 0 ma. Similarly we can estimate the instantaneous screen current at the crossing of OA and the "Operating Line" as 165 ma, and the instantaneous grid current at 60 ma. Values are read for the other crossings and written down. These values are put in simple columns for calculating:

Crossing of line	Simplified Name in Formulas	Instantaneous Values of Currents		
		Plate	Screen	Control Grid
OA	A	500 Ma	165 Ma	60 Ma
OB	B	510	100	50
OC	C	460	25	30
OD	D	290	5	14
OE	E	80	0	0
OF	F	0	0	0

Now in order to obtain the DC value of plate, screen, and control grid currents the formula (see computor) says to add up the above values but use only one-half of the A values (giving 250 ma for plate, 82 ma for screen, and 30 ma for grid), and then divide by 12, as follows:

DC Meter Reading = 1/12 (0.5 A+B+C+D+E+F)

Plate	Screen	Control Grid
250 Ma	82 Ma	30 Ma
510	100	50
460	25	30
290	5	14
80		
Total 1590 Ma	212 Ma	124 Ma
DC Current = 1/12 Total = 132 Ma	18 Ma	10 Ma

Now to calculate the RF output power it is necessary to use the formula for the peak RF current which is present in the tube plate current. Since we are using the tube as a straight RF power amplifier we use the formula for "Peak Fundamental RF" as shown on the computor. (If we were estimating the performance of a doubler or tripler we would use the formula for "Peak 2nd Harmonic RF" or "Peak 3rd Harmonic RF".)

From the computor we see that the formula for the peak fundamental RF current is:

1/12 (A+1.93 B+1.73 C+1.41 D+E+0.52 F)

A = 500 = 500 Ma
1.93 B = 1.93x 510 = 985
1.73 C = 1.73x 460 = 796
1.41 D = 1.41x 290 = 409
E = 80 = 80

Total = 2770 Ma

Peak fundamental current = 1/12 Total = 2770/12 = 230 Ma

We now have the various current values. In order to calculate the powers involved it is necessary to know, not only the DC voltage values, but the greatest amount each voltage swings away from the DC value. This is known as the peak value of the RF voltage. Because the plate voltage swings from 2000 volts down to 250 volts the peak RF voltage is the difference, or 1750 volts. Similarly the grid voltage must rise and fall between the operating points No. 1 and No. 2, or from −125 volts to +95 volts. This is a peak swing of 220 volts and the peak RF grid voltage is 220 volts.

Let us now use the formulas for output power and driving power:

Output power = ½ peak RF plate current x peak RF plate voltage.

We found the peak RF plate current to be 230 ma or .230 amperes, and the peak RF plate voltage to be 1750 volts.

So; Output Power = ½ x .230 x 1750 = 201 watts,
and Input Power = DC Plate Current x DC Plate Voltage = .132 x 2000 = 264 watts
Plate Dissipation = DC Input Power—RF Output Power = 264 − 201 = 63 watts
Efficiency = RF Output Power divided by DC Input Power = 201/264 = 76%
Driving Power = DC Grid Current x Peak RF Grid Voltage
So the Driving Power = .010 x 220 = 2.2 watts

The power consumed by the bias source is simply the product of the DC grid current and the DC grid voltage, or .010 x 120 = 1.2 watts.

The difference between the driving power and the power consumed by the bias source is the power dissipated on the control grid, or 2.2 − 1.2 = 1.0 watts.

The power dissipated on the screen grid is simply the product of the DC screen current and the DC screen voltage, because the screen grid has no impedance between it and the DC screen supply. Thus it is .018 x 250 = 4.5 watts.

The performance of the tube can now be summarized:

DC Plate Voltage	2000 Volts	Driving Power	2.2 Watts
DC Screen Voltage	250 Volts	Grid Dissipation	1.0 Watts
DC Grid Voltage	—120 Volts	Screen Dissipation	4.5 Watts
DC Plate Current	132 Ma	Plate Power Input	264 Watts
DC Screen Current	18 Ma	Plate Power Output	201 Watts
DC Grid Current	10 Ma	Plate Dissipation	63 Watts
Peak RF Grid Voltage	220 Volts		

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7. "Vacuum Tube Ratings," Eimac Application Bulletin Number 6
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Eimac®
EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA
NUMBER 5

TUBE PERFORMANCE COMPUTOR

DETAILED INSTRUCTIONS

TUBE PERFORMANCE COMPUTOR FOR R-F AMPLIFIERS (CLASS B, C, AND FREQUENCY MULTIPLIERS)

It is quite easy to make a close estimate of the performance of a vacuum tube in radio-frequency power-amplifier service, or an approximation in the case of harmonic-amplifier service. Such estimates will give r-f output power, d-c input power, grid driving power, and all d-c current values.

These estimates can be made easily by using the Eimac Tube Performance Computor and the characteristic curves of a tube, plotted on plate-voltage/grid-voltage coordinates (constant-current curves). Only the ability to multiply figures taken from the curves, by means of the computor, is required.

By graphically laying out the trace of the plate and grid voltages as they rise and fall about the applied d-c plate voltage and d-c grid bias, a clear understanding of the action taking place within a tube is possible. With such an understanding the operating conditions can be altered readily to suit one's particular requirements.

Simple Action in Class-C R-F Amplifiers

In an amplifier a varying voltage is applied to the control grid of the tube. Simultaneously the plate voltage will vary in a similar manner, due to the action of the amplified current flowing in the plate circuit. In radio-frequency applications with resonant circuits, these voltage variations are smooth sine-wave variations, 180° out of phase (as the grid voltage rises and becomes *more* positive, the plate voltage falls and becomes *less* positive) as indicated in Fig. 1. Note how these variations center about the d-c plate voltage and the d-c control-grid bias.

Let us now see how such variations of the plate and grid voltages of a tube appear on the constant-current curves of a tube. In Fig. 2 these variations have been indicated next to the plate-voltage and grid-voltage scales of a typical constant-current curve. At some instant of time, shown as "t" on the time scales, the grid voltage has a value which is the point marked "eg" on the grid-voltage sine wave. If one now finds the point on the tube curves corresponding to these values (where a line drawn from "eg" and a line drawn from "ep' cross) he will be at point A in Fig. 2. As the values of grid voltage "eg" and plate voltage "ep" vary over the r-f cycle, the point A moves up and down a line, which in the case of the normal r-f power amplifier is a straight line. This line is called the "Operating Line."

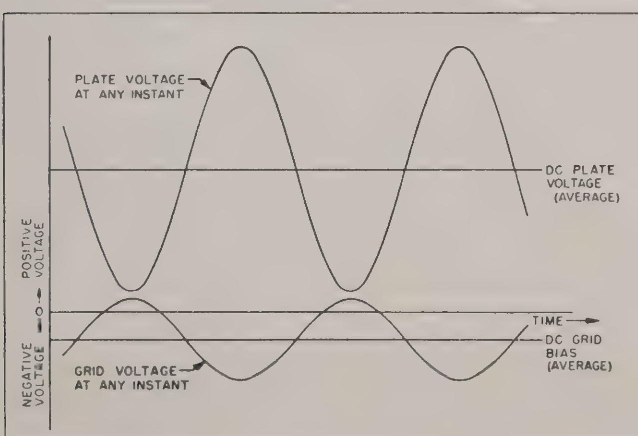


Figure 1

Any point on the operating line (when drawn on constant-current curves as in Fig. 2 or Fig. 4) tells the instantaneous values of plate current, screen current, and grid current which must flow when those particular values of grid and plate voltage are applied to the tube. Thus by reading off the values of the currents and plotting them against the time "t", one can obtain a curve of

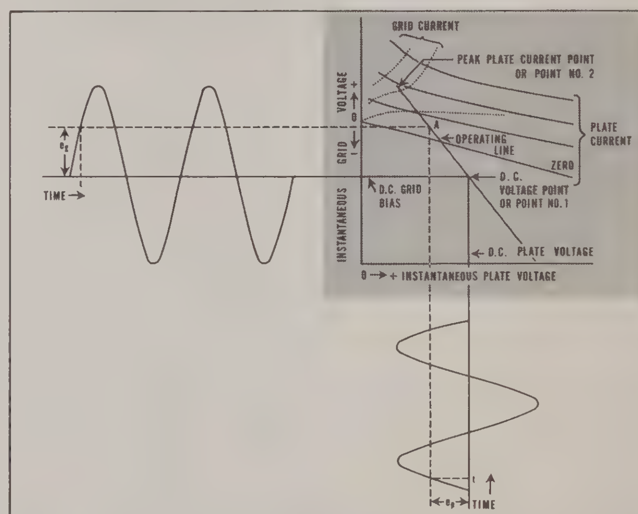


Figure 2

instantaneous values of plate and grid current. See Fig. 3.

If we analyze the plate and grid-current values shown, we can predict that they will cause a d-c ammeter to show a particular reading. This is called the d-c component of the current. Also, we can predict that if the plate current flows through a properly loaded resonant r-f circuit a certain amount of radio-frequency power will be delivered to that circuit. If the circuit is tuned to the fundamental frequency (same frequency as

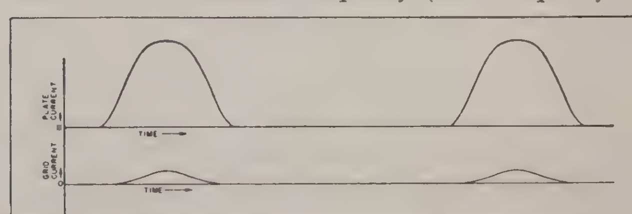


Figure 3

the r-f grid voltage) the power delivered will be due to the fundamental, or principal, radio-frequency component of plate current. If the circuit is tuned to a harmonic of the grid-voltage frequency, e.g., two or three times the frequency, the power delivered will be due to a harmonic component of the plate current.

Use of the Eimac Tube Performance Computor

The Eimac Tube Performance Computor gives us the means to make these simple calculations. It is a means with which to determine the d-c component, the fundamental r-f component, or the approximate harmonic component of the current flowing in a tube when the tube is operating as a radio-frequency amplifier, and enables one to state what all meter readings will be and to predict the r-f output power and the required driving power. With these factors known we are able to forecast what will happen if any of the operating conditions are changed.

The Eimac Tube Performance Computor is a simple aid to enable one to select suitable values from the characteristic curves of a tube, and by means of simple calculations to forecast the performance of the tube in radio-frequency power amplifiers.

The basic steps are outlined under "Instructions" on the computor. This requires selecting d-c plate and grid-bias voltages, being guided by the typical operating values given on the technical data sheet for the tube type, and by general experience. Next, a suitable "Operating Line" must be chosen on the constant-current curves for the tube type (plotted on grid-voltage/plate-voltage coordinates).

The computor, when properly placed over this operating line, enables one to obtain instantaneous values of the currents flowing at every 15° of the electrical cycle. The formulas given on the computor were derived by Chaffee[1] to give the various average and harmonic components of the resulting currents. Knowing these current component values and the radio-frequency voltage values which are indicated through use of the computor, one can readily calculate the complete performance of the tube.

The fundamental methods of making such computations, and the considerations necessary to stay within ratings of the tube types while accomplishing various forms of modulation have been covered in the literature, [2, 3, 4, 5, 7]. The method for the case of harmonic-amplifier service is approximate and should be used only for tetrode and pentode tubes where the plate voltage has little effect on the amount of plate current flowing. A more exact method, showing that for harmonic operation the operating line is a simple Lissajou figure, has been described by Brown.[8]

The results obtained by using this computor for power-amplifier service can be applied in combination with the other methods given in the literature to give good accuracy with simpler procedures. The resulting accuracy is well within the normal variation of tube characteristics due to the normal variation in manufacturing dimensions of a tube. Since the published tube curves are only typical of the characteristics to be expected from a particular tube type, the calculated performance is well within the values obtained when different tubes of a given tube type are operated under the assumed conditions.

Example Showing Detailed Use of the Eimac Tube Performance Computor

Radio-Frequency Power Amplifier, Class-C (Telegraphy or FM)

Let us say that we have an Eimac 4-65A tetrode and want to make it work effectively. Also, let us assume that we have a 2000-volt d-c plate power supply available.

Within frequency limits, we know that a tube should be able to run in class-C amplifier service with about 75% efficiency, or in other words to convert 75% of the d-c plate input power into r-f output power. The difference, or 25% of the input power, is dissipated or lost as heat on the plate of the tube. The d-c plate input power is then about four times the power dissipated on the plate.

The 4-65A tetrode has a maximum rated plate dissipation of 65 watts, and, to illustrate performance near the maximum rating, we'll choose an input power four times the dissipation rating, or about 260 watts per tube. At 2000 volts the plate current per tube must then be 130 ma. It is usual practice in the case of tetrodes and the medium or low-mu triodes in class-C amplifier service for the d-c grid-bias voltage to be roughly two or three times the grid voltage necessary to cut off the flow of the plate current. By referring to the curves for the 4-65A, we decide to use a d-c grid-bias voltage of −130 volts.

Let us now locate the "Operating Line" on the constant-current curves for the 4-65A. See Fig. 4. First, mark the point where the d-c grid bias and d-c plate voltage cross. The "Operating Line" must go through this point. Call it point No. 1. Next, we must decide what the peak value of plate current of the tube must be and how low we can let the instantaneous value of plate voltage go when the tube is passing this much current. This is necessary in order to locate the other end of the "Operating Line," point No. 2.

The peak value of plate current in class-C amplifiers usually runs about four times the d-c plate current. The minimum value of instantaneous plate voltage is usually set by the fact that if the voltage is too low, the grid current in triodes and the screen current in tetrodes will be needlessly high, resulting in high grid or screen dissipation. Also, little will be gained as far as output power

COMPUTER

EITEL-McCULLOUGH, INC.

TUBE PERFORMANCE COMPUTER
For RF Amplifiers (Class B, C, and Frequency Multipliers)

Use with constant current curves to obtain plate, grid, and screen current values; also output and driving power.

DC Current meter reading:	1/12 (0.5A+B+C+D+E+F)
Peak fundamental RF	1/12 (A+1.93B+1.73C+1.41D+E+0.52F)
Peak 2nd Harmonic RF (Approx.)*	1/12 (A+1.73B+C-E-1.73F)
Peak 3rd Harmonic RF (Approx.)*	1/12 (A+1.41B-1.41D-2E-1.41F)

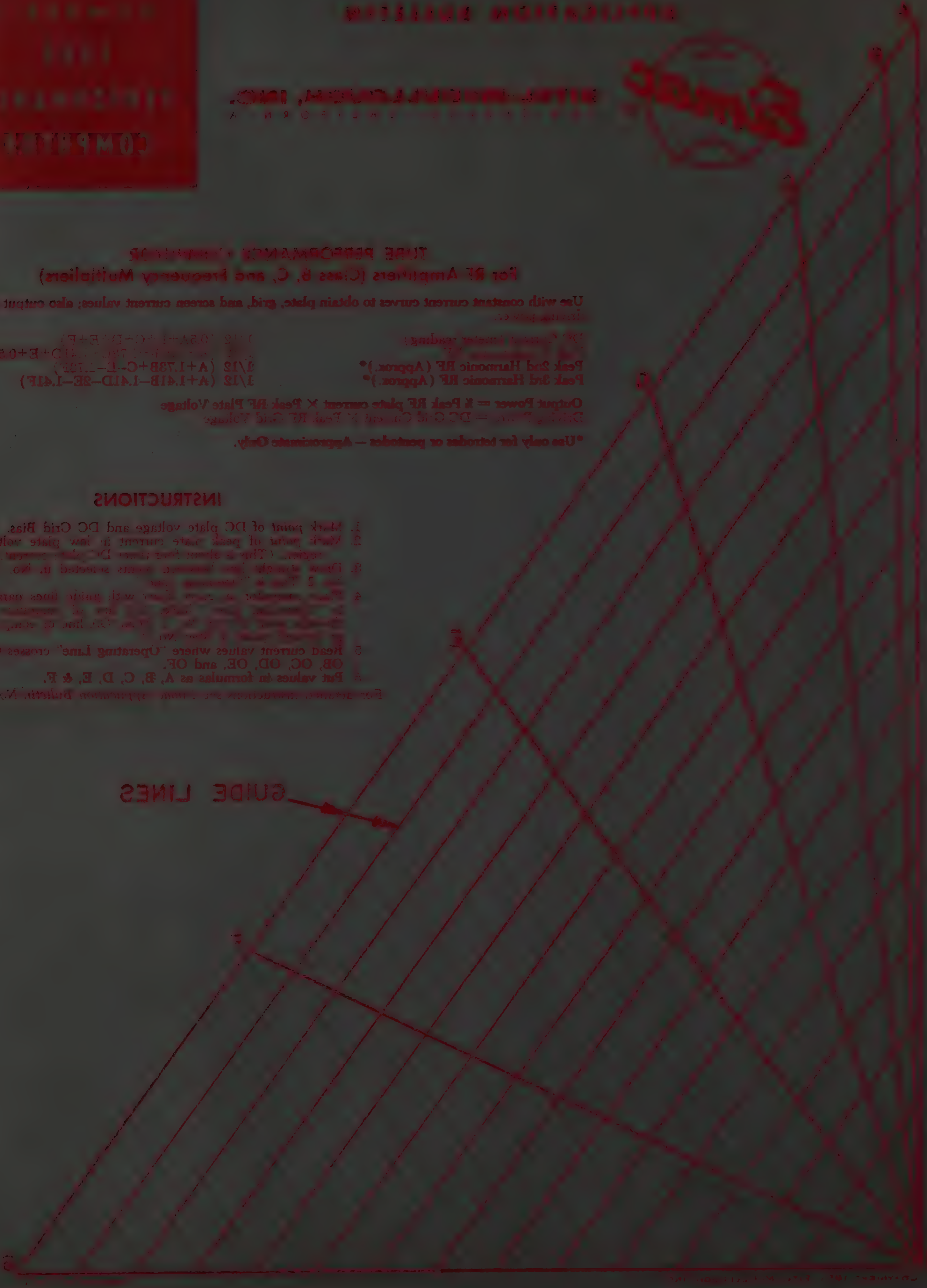
Output Power = ½ Peak RF plate current × Peak RF Plate Voltage
Driving Power = DC Grid Current × Peak RF Grid Voltage

*Use only for tetrodes or pentodes — Approximate Only.

INSTRUCTIONS

1. Mark point of DC plate voltage and DC Grid Bias.
2. Mark point of peak plate current in low plate voltage region. (This is about four times DC plate current.)
3. Draw straight line between points selected in No. 1 & No. 2. This is "Operating Line".
4. [illegible]
5. Read current values where "Operating Line" crosses OA, OB, OC, OD, OE, and OF.
6. Put values in formulas as A, B, C, D, E, & F.

For detailed instructions see Eimac Application Bulletin No. 5.



is concerned. The minimum value of plate voltage is usually in the region where the plate constant-current curves bend upward. See Fig. 4. (In the case of the triode this is near the "diode line," the imaginary line where the instantaneous grid and plate voltages are equal.) The practical procedure in calculating tube performance is to arbitrarily choose point No. 2, complete the calculations, and compare the results.

In the case of the 4-65A let us choose a peak value of plate current about four times the d-c plate current of 130 ma, or 500 ma. Let us choose a minimum instantaneous plate voltage of 250 volts and thus fix the upper end of the "Operating Line." Next, locate this point on the tube curves. This is point No. 2 on Fig. 4. (The plate currents which flow at various combinations of plate and grid voltages are shown by the plate-current lines. The value of current for each line is noted. In-between values can be estimated closely enough for our purposes.) Now draw a straight line between points No. 1 and No. 2. This line is the "Operating Line" and shows the current and voltage values at each instant in the r-f cycle when current is being taken from the tube. (The non-conducting half of the r-f cycle would be shown by extending this line an equal distance on the opposite side of point No. 1. However, there is little use in doing so, because no current flows during this half of the cycle.)

The Eimac Tube Performance Computer can now be used to obtain the meter readings and power values from this "Operating Line." Place the computor on the constant-current curve sheet so that the "guide lines" of the computor are parallel with the operating line. Now slide the computor without turning it until the line OG passes through the d-c voltage point No. 1 and line OA passes through the peak-current point No. 2. *Make sure the guide lines are still parallel to the "Operating Line."*

Note that the lines OB, OC, OD, OE, and OF of the computor all cross over the "Operating Line."

At each point where the lines OA, OB, etc., cross the "Operating Line" we need to determine the instantaneous values of plate current and grid current (and screen current if a tetrode or pentode is used) which are flowing at that particular moment in the r-f cycle. Later, from these key values of current, we will calculate the values of d-c plate current and grid current (and screen current) as well as the r-f components of the plate current.

These current values should be listed for each point where the lines OA, OB, etc. cross the operating line so that they can be combined later to caculate the various tube currents. At points where OF and OE cross, the current values are usually zero for class-C operation.

Now in the example chosen, let us read off the instantaneous plate-current values where these lines cross the "Operating Line." At the point where the line OA crosses the "Operating Line" the plate current is 500 ma.

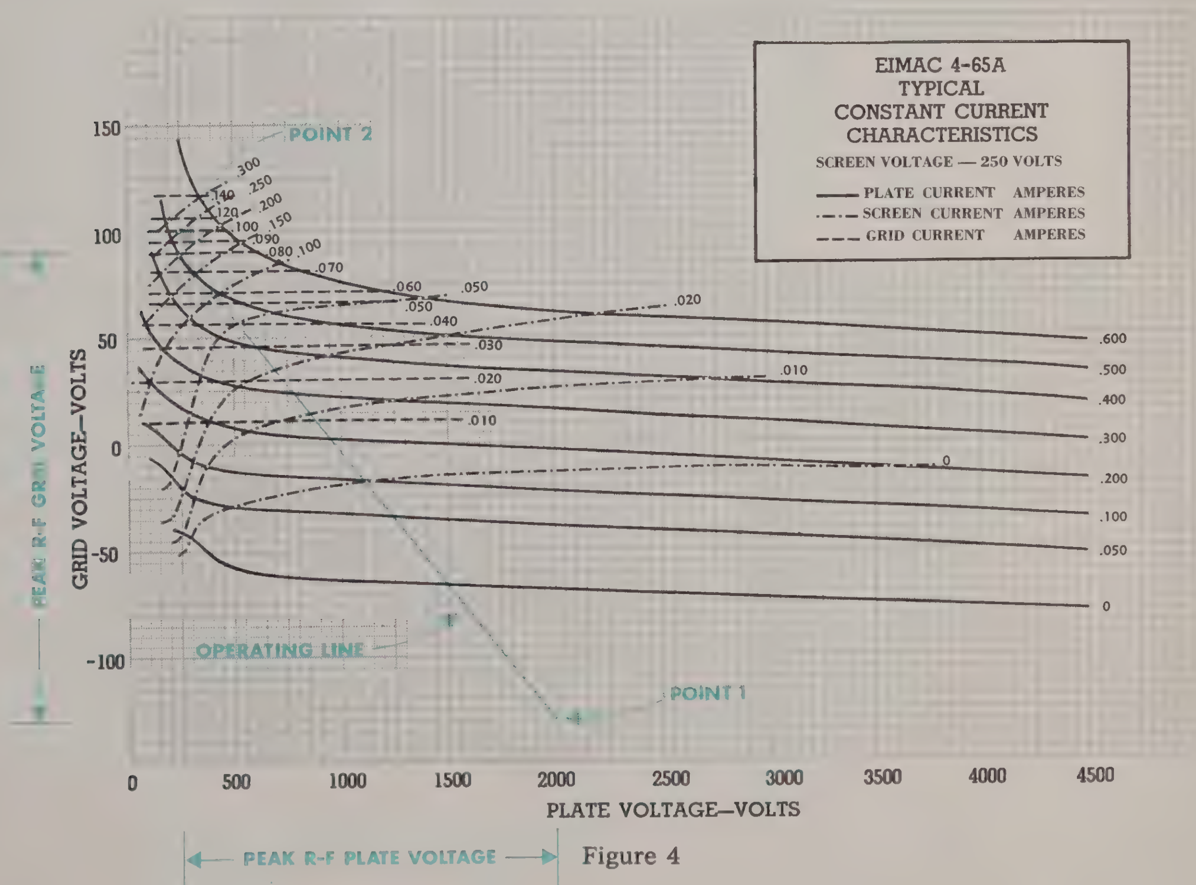


Figure 4

Where OB crosses the operating line the plate current is also 500 ma. At OC the plate current is about 450 ma, OD 300 ma, OE 90 ma, OF and OG 0 ma. Similarly we can see that the instantaneous screen current at the crossing of OA and the "Operating Line" is 200 ma, and the instantaneous grid current is almost 80 ma. Values are read for the other crossings and written down. These values are put in simple columns for calculating:

Crossing of line	Simplified name in Formulas	Instantaneous values of currents		
		Plate	Screen	Control grid
OA	A	500 ma	200 ma	80 ma
OB	B	500	155	70
OC	C	450	60	42
OD	D	300	15	17
OE	E	90	0	0
OF	F	0	0	0

Now in order to obtain the d-c value of plate, screen, and control-grid currents the formula (see computor) says to add up the above values but use only one-half of the A values (giving 250 ma for plate, 100 ma for screen, and 40 ma for grid), and then divide by 12, as follows:

D-C meter reading = 1/12 (0.5 A+B+C+D+E+F)

Plate	Screen	Control grid
250 ma	100 ma	40 ma
500	155	70
450	60	42
300	15	17
90	0	0
0	0	0
Total 1590 ma	330 ma	169 ma

D-C current = 1/12 total = (approximately)

Plate	Screen	Control grid
133 ma	28 ma	14 ma

Now, to caculate the r-f output power it is necessary to use the formula for the peak r-f current which is present in the tube plate current. Since we are using the tube as a straight r-f power amplifier, we use the formula for "Peak Fundamental R-F" as shown on the computor. (If we were estimating the performance of a doubler or tripler we would use the formula for "Peak 2nd Harmonic R-F "or "Peak 3rd Harmonic R-F".)

From the computor we see that the formula for the peak fundamental r-f current is:

1/12 (A+1.93B+1.73C+1.41D+E+0.52F)

A= 500=500 ma
1.93B=1.93 x 500=965
1.73C=1.73 x 450=778
1.41D=1.41 x 300=423
E= 90= 90

Total =2756 ma

Peak fundamental current=1/12 total =2756/12=230 ma

We now have the various current values. In order to calculate the powers involved, it is necessary to know not only the d-c voltage values but the greatest amount each voltage swings away from the d-c value. This is known as the peak value of the r-f voltage. Because the plate voltage swings from 2000 volts down to 250 volts the peak r-f plate voltage is the difference, or 1750 volts. Similarly the grid voltage must rise and fall between the operating points No. 1 and No. 2, or from —130 volts to +90 volts. This is a peak swing of 220 volts and the peak r-f grid voltage is 220 volts.

Let us now use the formulas for output power and driving power:

Output power = ½ peak r-f plate current x peak r-f plate voltage.

We found the peak r-f plate current to be 230 ma or .230 ampere, and the peak r-f plate voltage to be 1750 volts.

So; Output Power = ½ x 0.230 x 1750 = 201 watts,
and Input Power = D-C Plate Current x D-C Plate Voltage = 0.133 x 2000 = 266 watts
Plate Dissipation = D-C Input Power — R-F Output Power = 266 — 201 = 65 watts
Efficiency = R-F Output Power divided by D-C Input Power = 201/266 = 75.5%
Driving Power = D-C Grid Current x Peak R-F Grid Voltage = 0.014 x 220 = 3.1 watts

The power consumed by the bias source is simply the product of the d-c grid current and the d-c grid voltage, or 0.014 x 130 = 1.7 watts.

The difference between the driving power and the power consumed by the bias source is the power dissipated on the control grid, or 3.1 — 1.7 = 1.4 watts.

The power dissipated on the screen grid is simply the product of the d-c screen current and the d-c screen voltage because the screen grid has no impedance between it and the d-c screen supply. Thus it is 0.028 x 250 = 7.0 watts.

The performance of the tube can now be summarized:

D-C Plate Voltage	2000 volts	Driving Power	3.1 watts
D-C Screen Voltage	250 volts	Grid Dissipation	1.4 watts
D-C Grid Voltage	—130 volts	Screen Dissipation	7.0 watts
D-C Plate Current	133 ma	Plate Input Power	266 watts
D-C Screen Current	28 ma	Plate Output Power	201 watts
Peak R-F Grid Voltage	220 volts	Plate Dissipation	65 watts

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7. "Vacuum Tube Ratings," Eimac Application Bulletin Number 6
8. Robert H. Brown, "Harmonic Amplifier Design," Proc. IRE, Vol. 35, pp. 771-777, August 1947

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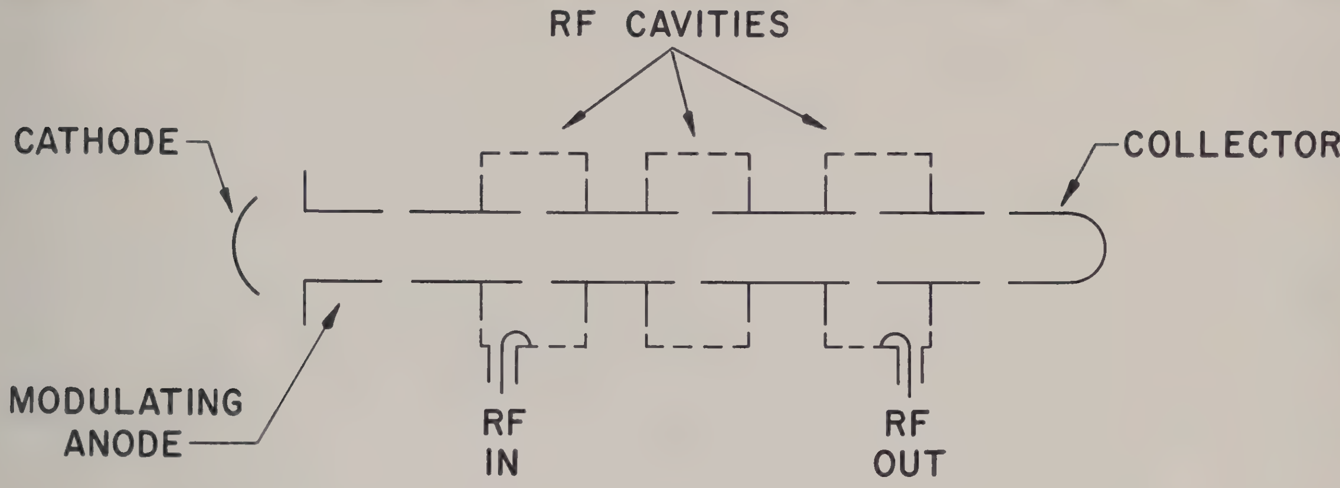
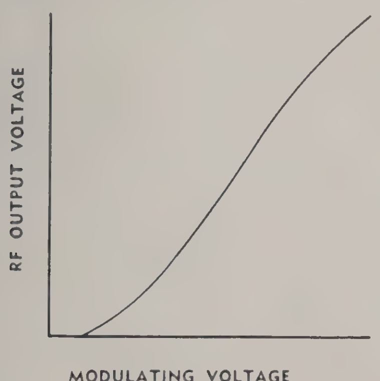
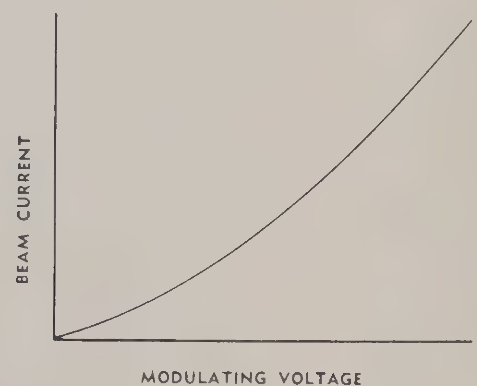
MODULATING ANODE KLYSTRONS



Eimac's revolutionary new modulating anode klystrons employ an insulated anode placed between the cathode and drift tube section.

By varying the voltage on the modulating anode the amount of beam current can be varied at will, and independently of the beam voltage of the Klystron. A multitude of new operating possibilities are thus opened up.





Because of the focusing action of the Klystron gun, the current drawn by the modulating anode is negligible. The modulating anode permits a Klystron:

- to be pulse modulated easily with low pulsing power.
- to be amplitude modulated with low modulating power.
- to operate as a modulated RF amplifier and deliver a carrier capable of 100% modulation, with carrier efficiency of 30%, whereby without this feature the RF linear Klystron would have a carrier efficiency of less than 10%.
- to perform additional functions using the controlling action of the modulating anode.

Understanding Tetrode Screen Current

Significance in R.F. Amplifier Adjustment and Operation

BY DAVID D. MEACHAM,* W6EMD

> ***This article discusses the behavior of screen current in a tetrode r.f. power amplifier using fixed screen voltage, and explains why a screen-current meter is a better indicator of operating conditions than a plate-current meter. Particular reference is made to the adjustment of AB_1 linear amplifiers.***

Perplexing screen-current behavior has probably disturbed many amateurs, particularly single-sideband operators. The need for a thorough discussion of the subject has prompted this article. Class AB_1 operation has been chosen for discussion because of its current popularity as a means of achieving good linearity and TVI-free operation. The information given herein assumes grid-driven conditions, but it applies equally well to cathode-driven tetrodes operated Class AB_1 with normal d.c. voltages on the grid and screen, provided that grounded-grid characteristic curves are used for computations.

Screen Characteristics

Fig. 1 shows a set of *constant-current characteristics* for a typical 4CX300A. The term "constant current" is used because the lines plotted are lines of constant plate, screen, or grid current. The grid-voltage scale appears on the left axis and plate voltage is shown horizontally. These curves depict *instantaneous values* of plate and screen current for any given grid- and plate-voltage condition. In this reproduction, the grid-current lines are omitted because grid current is not drawn in Class AB_1 operation. The curves are valid only for a *fixed* screen voltage (350 volts in this case).

Inspection of Fig. 1 will reveal that the lines of constant plate current are nearly horizontal, whereas the constant-screen-current lines are tilted upward from left to right and are concentrated in the left-hand region of the plot. This is generally true for all tetrodes and accounts for the fact that the screen-current meter is *the most sensitive indicator of resonance.* This important fact will be explained subsequently.

Let us plot a typical operating line[1] on our set of curves, as in Fig. 1. Point O (at −55 volts on the grid in this case) is the operating point at which the tube rests with zero r.f. grid drive. Straight line OA represents a tuned r.f. circuit load (a pure resistance at the operating frequency).[2] As 100 volts peak-to-peak grid drive is applied, the first positive half cycle can be represented by a point moving along the operating line from O to A and back to O again. During this half cycle, the grid-voltage swing from −55 volts up to −5 volts and back to −55 volts has caused the plate current to swing from the value at point O (100 ma.) up to the value at point A (850 ma.) and back to 100 ma. again. At the same time, the plate voltage swings from 2000 volts down to 500 volts. The a.c. plate current is made up of all the instantaneous values intercepted by the point traveling along the operating line. The same is true of screen current. During the other 180 degrees of the driving cycle, our point merely travels from O down the slope through cutoff to a point opposite −105 volts on the grid-voltage scale and back to point O again along the operating line. Thus, the negative-going grid voltage swings the plate current down to cutoff (for a small portion of the cycle). Plate voltage continues on up to 3500 volts and back down again due to the fly-wheel action of the plate tank circuit.

* c/o Eitel-McCullough, Inc., San Carlos, Calif.

[1] This is different from the usual load line associated with audio calculations using plate characteristic curves.

[2] OA is actually only half the operating line length. The other half continues from O out beyond the right-hand edge of the chart for an equal distance and represents the effect of the negative half-cycle of grid driving voltage as it swings down to −105 volts and back to point O again. This half of the operating line is not important since the tube does not "work" during the negative half cycle.

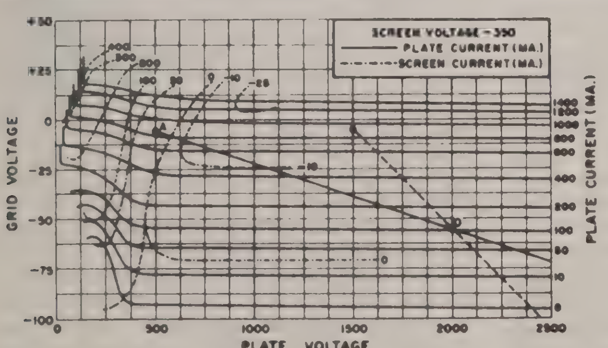


Fig. 1—Typical constant-current characteristics for the Eimac 4CX300A tetrode.

Drive and Tuning

Now that we can predict exactly what the screen and plate current will be for any *instantaneous point* during the grid-voltage cycle, let us ask some more probing questions. What happens when we cut our grid-driving voltage in half? The answer is simple. The *length* of our operating line is merely cut in half! The grid voltage swings to only one half the original peak-to-peak amplitude and the operating point O is still the center of the new operating line length. Now what happens if we detune the plate tank circuit? Detuning the plate circuit actually changes the plate load impedance. How does this appear on our set of curves? It tilts or rotates the operating line *about the operating point* O. As the load impedance is lowered (detuning from resonance), the operating line[3] assumes a steeper angle (a zero-impedance load would be represented by a vertical operating line).

As "seen" by the tube, the act of tuning to resonance amounts to increasing the load impedance to a maximum value consistent with the degree of antenna loading selected. Thus, the operating line will have *minimum slope* at resonance. Notice the angle at which our typical operating line in Fig. 1 cuts the constant-plate-current lines. It's a small angle. As the plate tank circuit is tuned to a point out of resonance, the operating line might assume the position indicated by the dashed line[3] (lower impedance). Note that the angle between the dashed line and the plate-current lines has not changed radically, and that our moving point will still intercept *essentially the same plate-current values*. This is precisely the reason that plate current in a tetrode is not a good indicator of resonance (very little dip). Look at the screen current. It consists of zero or even negative values in the out-of-resonance position. At resonance, though, it is positive. Thus, a peak in screen current *indicates resonance*.

During the rotation of the operating line while tuning, its length actually changes, since it is confined vertically only by the constant peak-to-peak amplitude of the grid-driving voltage (two imaginary horizontal lines, one at -5 volts and one at -105 volts). The length increases as resonance is approached and reaches a maximum at resonance. As the length increases, point A penetrates the heavy-screen-current region and the d.c. screen current reaches a sharp peak at resonance.

Loading

What happens if we change the antenna loading? This merely changes the plate-load impedance (still resistive). Again, the effect is to tilt the operating line about the operating point. As the load impedance is lowered (more coupling), the operating line assumes a steeper angle (such as the dashed line). It is easy to see that as loading increases, screen current decreases. Thus, screen current is *also an indicator of loading*. Screen current varies somewhat from tube-to-tube of a given type, but if each tube is loaded to the same value of screen current at resonance (with the same drive) power output differences will be small, and loading and linearity will be essentially the same.

D.C. Meter Readings

During the r.f. cycle, our point traverses the operating line and intercepts many different instantaneous values of screen current and plate current. The *average* of all these values is what the d.c. meter in the circuit reads. The *fundamental frequency component* of plate current is utilized in the plate circuit to produce output (except in a multiplier where use is made of a harmonic component of plate current). For a given operating line, both of these values can be calculated.[4] Suffice it to say that for Class AB_1 operation, the d.c. meter reading is approximately one third the peak value of current at the top of the operating line, and the fundamental component of plate current is approximately one half the peak value.

Tune-Up Procedure

Contrary to somewhat popular opinion, a linear amplifier should *never* be loaded for maximum power output. Loading should be set to obtain a predetermined value of screen current under single-tone or inserted-carrier driving conditions. Ideally, loading should be set for minimum distortion — a rather difficult feat in practice. It is recommended that the amateur try to duplicate as nearly as possible a given set of data-sheet conditions as presented by the tube manufacturer. These typical operating conditions are usually given for peak-envelope operation (single-tone or inserted-carrier) and represent the maximum input on c.w. or the peak-envelope-power input (*not* meter peaks) on single sideband. After adjusting drive, tuning, and loading to duplicate a given set of conditions, the single tone (or carrier) is removed and the single-sideband audio gain is adjusted so that grid current is never drawn and the condition adjusted for above is never exceeded on peaks. The peak-to-average ratio of d.c. plate current (as read on a fluctuating meter) varies, with the individual voice, from about 2:1 to over 3:1. Thus it is normal on voice peaks for the plate-current meter to read no more than *half* the value of current obtained in the maximum static single-tone condition.

A straightforward tune-up procedure consists of the following steps:

1) Insure that the tetrode amplifier is neutralized and free of parasitics.

2) With recommended heater, plate, and screen voltages applied, adjust the d.c. grid bias to obtain the recommended zero-signal value of plate

[3] The tank-circuit impedance would no longer appear resistive at the operating frequency, but would contain a reactive component. Under these conditions, the operating line becomes an ellipse whose center is point O and whose major axis is represented by the dashed line.

[4] By the use of the Eimac Tube Performance Computor, Application Bulletin No. 5, which is based on the method presented by Chaffee in the *Review of Scientific Instruments*, October, 1936.

current. This value affects linearity and plate dissipation.

3) Connect a suitable dummy load and set the loading control for rather heavy loading.

4) With a single-tone source, gradually increase the drive from zero to a value that produces a significant though small change in screen current.

5) Resonate the plate tank circuit by tuning for a *peak* (in the positive direction) *in screen current.*

6) Resonate the grid tank circuit (if any) by watching for a *peak in plate current.*

7) Now increase the drive until either the desired value of single-tone screen or plate current is reached (whichever is reached first).

8) Without drawing grid current, adjust loading, plate-tank tuning, and drive level to duplicate as nearly as possible a given set of data-sheet peak-envelope conditions. Remember that plate current increases with drive, whereas screen current peaks at resonance and decreases with heavier loading.

After matching a set of data-sheet conditions, the amplifier is ready to connect to an antenna. With a suitable antenna connected, it should be easy to repeat the operation obtained in Step 8 above by merely adjusting plate-tank tuning and loading with the same drive level as before. Now set up for voice single-sideband drive and adjust the audio gain for the highest level possible without drawing grid current on voice peaks or flat-topping (check this with a scope).

Reverse Screen Current

Most transmitting tetrodes employing oxide-coated cathodes exhibit negative screen current under certain conditions of operation. This is nothing to get alarmed about — it merely means that on the average, more electrons are leaving the screen than are being intercepted by the screen. This results because of secondary electron emission at the screen grid. Small values of negative screen current are not detrimental to tube operation and are quite normal for some tetrodes. Such values usually appear under heavily-loaded conditions or during the idling condition.

Large values of negative screen current are abnormal and should be avoided. Excessive secondary emission usually results in higher values of intermodulation distortion. This condition also prevents an accurate determination of screen dissipation.

Protection

Screen protection can take many forms. Before using a given circuit, it should be analyzed to insure that it satisfies the two basic criteria for screen protection. First, the circuit connected to the screen must be capable of maintaining the proper screen voltage in the presence of moderate negative d.c. screen current, or normal positive values of current. Second, the protective circuitry must not allow a condition of excessive screen current (positive or negative) to persist, since this causes excessive screen dissipation and resultant tube failure.

The first of these two criteria can be easily satisfied by the use of a bleeder resistance connected directly from the screen to ground, in combination with a suitable well-regulated power supply. The bleeder resistance should be made equal to the screen voltage divided by the largest negative d.c. screen current to be expected for the particular tube used. This eliminates any power-supply problems (soaring voltage) when "supplying" negative screen current.

Complete screen protection satisfying both criteria can be obtained by adding a screen-current overload relay to a bleeder and regulated-power-supply combination. The overload relay will protect the screen against excessive currents, either positive or negative, and the regulated power supply will maintain the screen voltage at the proper value as the d.c. screen current varies. The bleeder resistance from screen to ground will not allow the screen voltage, in the presence of negative screen current, to rise above the proper value. This bleeder is good insurance, since even some regulated power supplies react in an undesirable manner when subjected to a negative-current load.

When using a screen-current overload relay, one can easily provide for manual resetting in the event of an overload. This feature allows time to consider why the overload occurred and prevents repeated successive overloads. Using an s.p.d.t. relay, merely connect the armature to the positive supply through the coil (with the usual pull-in-adjusting potentiometer shunting the coil). Connect the normally-closed contact to the screen through the screen-current meter and the normally-open contact through a resistor to ground.[5] Adjust this resistor so that the current through it will hold the relay closed, once it has been tripped. First, of course, the pull-in shunt should be adjusted for pull-in at the value of screen-bleeder current, plus screen current, that produces maximum rated screen dissipation. Now, with this circuit it will be necessary to shut off the screen supply (or push a circuit-breaking series reset button) to reset the overload relay after an overload has occurred.

In contrast to the protective scheme outlined above, voltage-regulator tubes offer a simple and nearly foolproof method of screen-current protection. Their use will completely satisfy the first criterion and also the second criterion insofar as positive current overloads are concerned. Since excessive negative current is uncommon, one may elect to disregard protection against its occurrence. VR tubes then become an inexpensive and practical solution for the amateur.

The VR tube solution consists of an appropriate combination of VR tubes (to add up to the desired screen voltage) connected in series to ground and fed from a high-voltage source through an adjustable dropping resistance. The screen bypass capacitor from screen to ground

[5] See Evans, "Screen Protection and More," *QST*, October, 1960. — *Ed.*

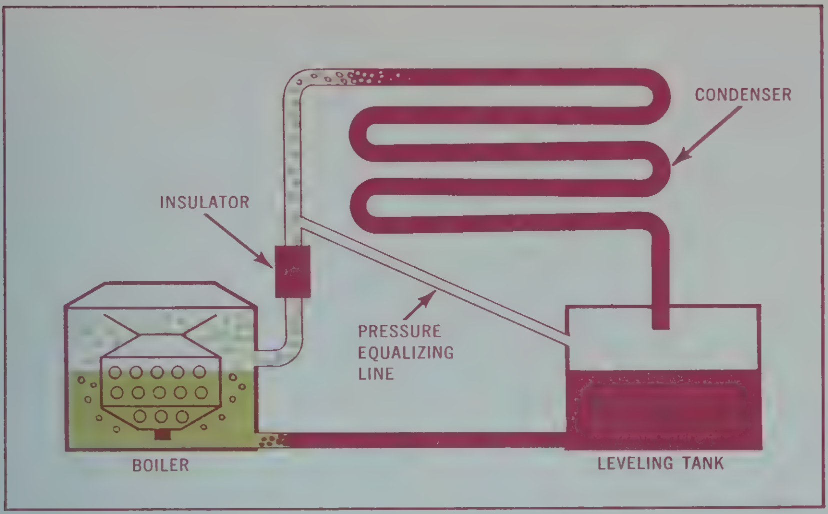
and a screen-current meter from screen to the top of the VR-tube string complete the circuit. Adjust the dropping resistance to so that the VR string extinguishes at or slightly lower than the value of screen current that produces maximum rated screen dissipation. R.f. screen-current peaks will be supplied by the screen bypass capacitance and the VR tubes will "see" only the d.c. component. Now, excessive positive screen current will extinguish the VR tubes, lowering the screen voltage. The VR tubes will supply normal positive current values while maintaining screen voltage at the desired value. Negative currents will not change the voltage, but will merely increase the current flowing through the VR tubes.

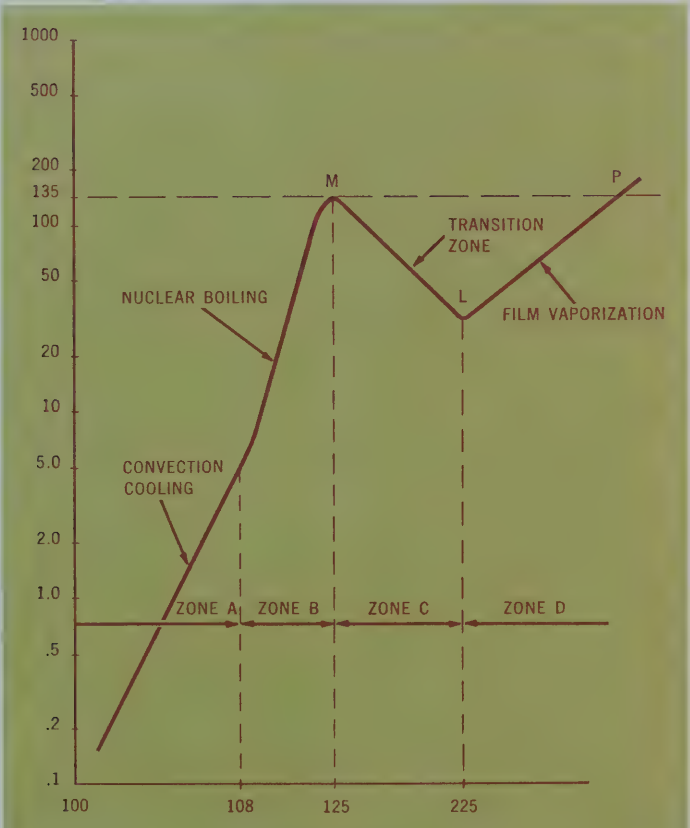
Use A Screen-Current Meter!

In conclusion, it should be obvious to the amateur that a screen-current meter is a vital necessity in modern transmitters employing tetrodes. By proper interpretation of screen-current readings, one can easily tune to resonance and properly load the tetrode amplifier. The plate-current meter is useful *only* as an indicator of drive level and *average* plate-input power (knowing the plate voltage). One more meter — for grid current — is useful but not absolutely necessary. A one-milliampere meter in the grid circuit will warn the operator by a slight kick when grid current is being drawn on voice peaks. QST


Eimac
HOW TO COOL A TUBE
WITH BOILING WATER

Traditionally, large electron tubes are cooled by blowing air past a finned anode or by passing water over the exterior surface of the anode.
Tradition is not always the best solution to an engineering problem.
Take water as a coolant, for example. The hotter it is, in relation to the air which ultimately absorbs its heat, the easier it is to transfer the heat. If the water is heated past the boiling point into its vapor phase, it even takes less water.
This accomplished quite a bit more than cooling. For one thing, it eliminates the pump associated with a water-cooled system. The steam pumps itself. Makes it a completely self-circulating set-up. No rotating parts. Take away the pump and you take away noise, a motor, possible contamination of the coolant and coolant loss due to leakage.
The amount of heat exchanger saving is considerable. Because steam is hotter, the differential temperature between the coolant and ambient air is greater, and it's easier to get the heat out of the coolant and into the air. Typically, vapor-phase cooling requires one-third the heat exchanger area which a water system requires, doing identically the same cooling job.
Then there is a noise. A water system with a pump and a high-velocity blower-type heat exchanger is going to make a great deal more noise than a vapor-phase system with no pump and a low-velocity fan type heat exchanger. Where ultimate simplicity, and dead-silence are wanted, Eimac will supply a system with enlarged condenser (still smaller than the water systemic exchanger) and *no* fan. The only moving part is the water.
Designers often need to increase the allowable anode dissipation of their chosen tubes. This may be the best all-around way to increase power output, for example. To do it safely, we must be sure the tube can pass increased heat to the coolant. We also must increase the capacity of the cooling system. It's true that you can remove as much heat from a tube with water as you could by vapor-cooling — under almost any set of operating conditions. But in most real cases, you would need to refrigerate the water and perhaps circulate it at ultra-high velocities. That means *more* equipment — a refrigeration system, bigger pumps, and again a relatively bigger heat exchanger. The vapor-cooled version of almost any tube permits higher anode dissipation and yet *decreases* system cost, maintenance cost, noise, size, and moving parts. Take the new Eimac 4CW50,000A, for example. 50 kilowatts with water. Its vapor-cooled version is 4CV75,000A. 75 kilowatts anode rating! Yet the surrounding cooling hardware costs less.
Designing a vapor-phase cooling system is a job for thermodynamics engineers. Up to now, United States electronic equipment designers have been expected to roll their own. Eimac thinks they shouldn't have to.





NUKIYAMA CURVE

A vapor-phase cooling system is simple, both in equipment and in application.

To cool a tube with vapor, you sink the anode in water and let it boil. The anode runs steadily at about the temperature of boiling water. Under its own steam, the vapor flows away to a heat exchanger. It's not under pressure. In fact, at some point in the system there's an open vent to the atmosphere. The heat exchanger, then, is a steam heater.

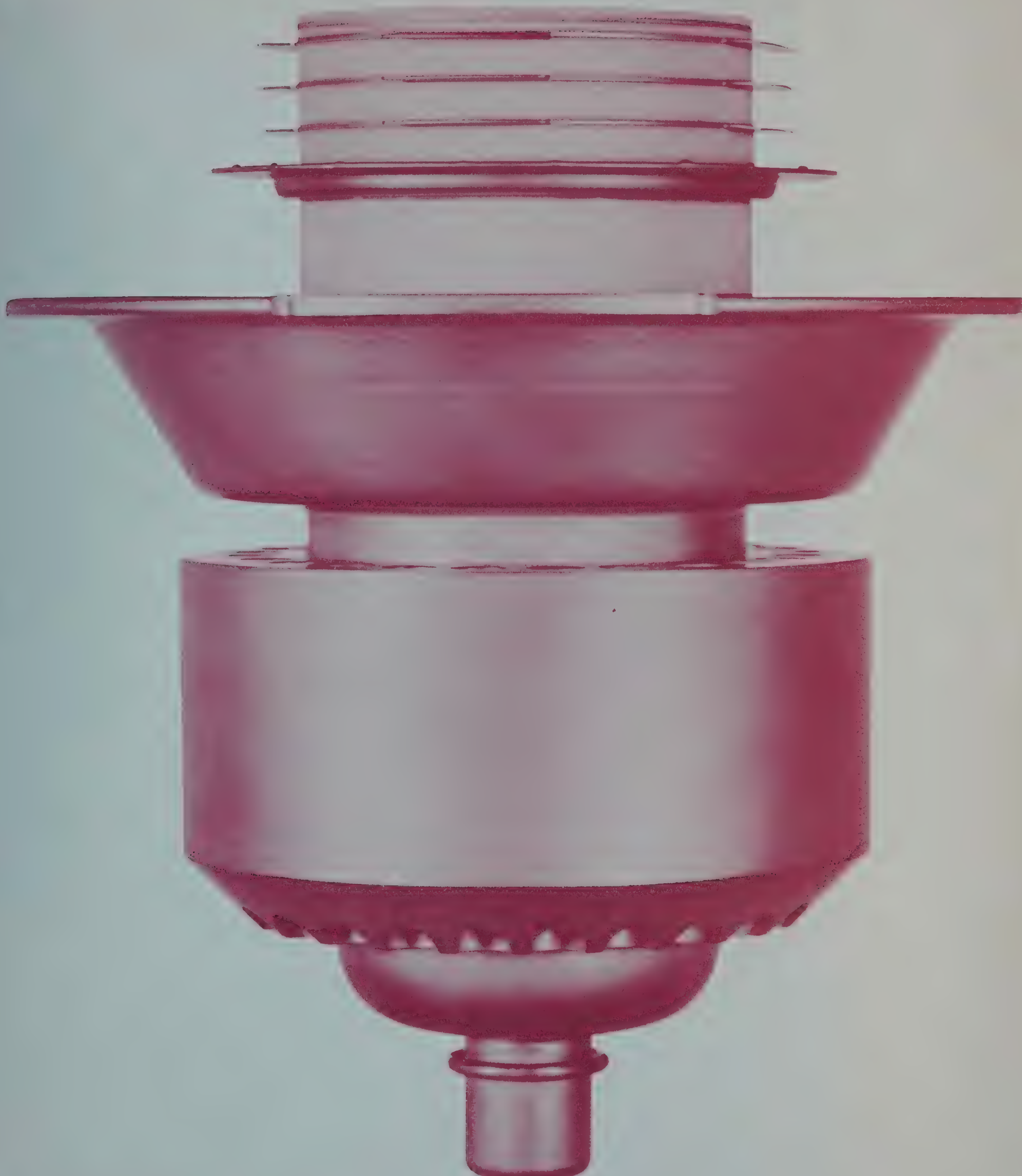
You can use it to heat air in your building, where that's desirable. If you want hot water, it will heat water. In the heat exchanger, the vapor condenses into water. So some of our diagrams call the heat exchanger a condenser. It's still a steam heater. Cools the tube, but heats outside air or water.

The condensed water vapor is returned to a leveling tank which is vented to the atmosphere. Unlike factory heating systems, this steam plant operates at atmospheric pressure. That's why we say vapor. "Steam" might suggest high-pressure turbines. We're cooling tubes. No pressure, just vapor.

The leveling tank replenishes the boiler. A reservoir assures a constant reserve of water, so the level in the boiler won't drop, even for a moment. Safe. A pipe between the condenser input and leveling tank keeps pressure differentials from developing. That's all there is to it. See the diagram. Simple, quiet, it works — thanks to the thermodynamics engineers.

First, the tube has to have an anode which takes to boiling water. Increased heat transfer capacity comes from increasing the area in contact with the water. It's important to keep it operating inside its most efficient temperature range, yet well below any temperature that's dangerous to the tube. Boiling has the advantage that it automatically provides controlled heat dissipation. Beyond a certain temperature a steady blanket of steam develops and the surface is no longer wet. With heat transfer thus reduced, the anode gets hotter and hotter . . . that's what the Nukiyama curve describes. You put a certain number of watts into a square centimeter of the anode I.D. area, the metal gets warm, and so does the water. More watts, and the metal gets hotter while the water boils. It's nucleate boiling. Bubbles of vapor form and rise. The metal remains wet. Metal temperature begins to get higher than water temperature. Still *more* watts produces faster boiling and hotter metal, but the vapor temperature remains constant. At point M calefaction takes place. Now the boiling is so furious the whole surface of the metal is covered with vapor bubbles and conductivity drops suddenly. More watts, and we reach the destruction point. Now the metal is covered with a continuous sheath of steam. It doesn't matter much to those of us whose only interest is in the now-defunct tube, but if we found a way to put still more watts into the metal, the situation would again improve. That is, with a still higher temperature differential, conductivity would again begin to level off the rate at which the metal temperature rises.

The best thing is to buy an Eimac tube designed to run comfortably at its rating below the destruction point. One design that's worked well is shown at right. Anode exterior and all the surface inside the holes gives a big area to form bubbles.



The boiler, tank and reservoir, want coordinated design, too. High-voltage anodes require a boiler insulated from other parts, and pure water but not very much water.

It takes 1 calorie of heat per gram of water to raise the temperature 1°C. From 99°C water, it takes 540 calories of heat to make it boil. If, in a water-cooled system, you maintain a difference of 25°C between tube-in and tube-out, you're doing pretty well. You dissipate 25 calories per gram. The ratio of 540 to 25 is over 20. So you'll circulate 1/20 as much water and dissipate the same heat.

So, vapor-phase cooling requires a tube designed for the purpose, a boiler to sink it in (with tube socket attached), some piping, a leveling tank, a reservoir and a condenser. All this comes neatly packaged, ready to drop into place in your new design. Eimac's condenser will be only about a third the size of the exchanger you'd need for the same water-cooled dissipation. And no pumps. No stills, for make-up water, either, since Eimac vapor-cooling systems use so little water to begin with and there is very little evaporation.

We haven't said much about vapor-cooling versus air cooling. That's because air is impractical at the higher powers. Somewhere below 10 kilowatts, air is preferred for most applications because it's easier to operate and maintain. But at all powers, it's noisy. It has some other problems, like dirt. Mainly, though, it's noisy. Silence alone may make vapor-cooling the best solution to some cooling problems, even at low powers. Or its ability to keep tube temperatures constant. Eimac makes a line of vapor-cooled tubes from the 4CV8000A (vapor-cooled version of the 4CX3000A) through the new 4CV45,000A to the new 4CV75,000A. 8 kilowatts, 45 and 75 kilowatts. And vapor cooling packages to match.

Vapor-cooled klystrons? Very much so. Since the klystron runs its heat-dissipating collector at ground potential, and since klystron power is often very high, the klystron lends itself very well to vapor-cooling. Here's a 4KM100LA, one of Eimac's distinguished new high-power UHF-TV klystrons, undergoing test with a vapor-cooled anode. Boiling prettily. High temperature differential between the resulting steam and atmosphere heat-sink cuts heat exchanger size and cost. 540 calories per gram when water changes to vapor at constant 100°C cuts water required. Silent. Just like the tetrode example, but savings are even greater because power level is so high. Ask us. Klystrons? Yes, indeed. We've already broadly hinted that your all-up cost for cooling will be a third that of a water system, if you use Eimac vapor-cooling instead of water.

And your maintenance costs may drop to one-fifth!

Make us prove it. It's drop-in ready. Call your Eimac man. Buy it. From Eimac.

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klystrons

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IMPORTANT EIMAC "EXTRAS"

Application Engineering. The Eimac Application Engineering Department is available at all times for consultation. New tube operating techniques are continually being explored, tested and proved by Eimac application engineers, whose combined knowledge and experience are made available to you. Additional contributions by this Eimac department are its Application Bulletins, an expanding service which you get without obligation.

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klystrons

TENTATIVE DATA

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

1K015XA AND 1K015XG KLYSTRONS

X-BAND OSCILLATORS

The EIMAC 1K015XA and 1K015XG are ruggedized, integral-cavity, X-band, reflex klystrons intended for local oscillator service under conditions of severe shock, vibration or sustained acceleration.

The 1K015X type tubes are available with either coaxial output or waveguide output. The r-f terminal of the 1K015XA is a coaxial connector. For waveguide output, the r-f terminal of the 1K015XG is the Eimac transition section.

1K015XA
(Coaxial Output)

1K015XG
(Waveguide Output)

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Coated Unipotential

Heater Voltage - - - - - - -	6.3	volts
Heater Current - - - - - - -	0.80	amperes
▶ Frequency Range - - - (8400 thru 9600 Mc)	800	Mc

(See paragraph: Mechanical Tuning in Application)

MECHANICAL

High Impact Shock* - - - - - - -	100	g
▶ Axial Vibration Test (20-2000 cycles)* - - -	10	g

Mounting (See Outline Drawing)
- 1K015XA: Three-hole flange and coaxial r-f terminal
- or
- 1K015XG: In conjunction with an Eimac transition section mounts directly on a UG-39/U waveguide flange

Connections:

Heater - - - - - - -	White wire at base
Heater and Cathode - - - -	Black wire at base
Resonator - - - - - - - -	Shell of tube
Repeller - - - - - - - -	White wire at top

Output (See Outline Drawings): 1K015XA: Coaxial fitting, 1K015XG: UG-39/U waveguide flange

*The shock and vibration tests are applicable to both coaxial and waveguide outputs.

▶ Indicates change from sheet dated 7-7-53

TENTATIVE DATA

Mounting Position		Any
Cooling		Convection and Radiation
Maximum Over-all Dimensions:	Coaxial Output	Waveguide Output
Length	2-3/8 inches	3-9/16 inches
Diameter	1-3/16 inches	———
Width	———	1-15/32 inches
Net Weight	1.5 ounces	6.5 ounces
Shipping Weight	4 ounces	8 ounces

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE	350 MAX. VOLTS
RESONATOR DISSIPATION	15 MAX. WATTS
▶ D-C CATHODE CURRENT	50 MAX. MA
D-C REPELLER VOLTAGE	
Positive Limit	0 MAX. VOLTS
Negative Limit	500 MAX. VOLTS

▶ TYPICAL OPERATION (With flat load)

Mode	6¾	7¾	5¾	6¾	
D-C Resonator Voltage	250	250	300	300	volts
D-C Cathode Current	36	36	47	47	mA
D-C Repeller Voltage	-110	-65	-170	-95	volts
Power Output	45	30	100	65	mW
Frequency	9000	9000	9000	9000	Mc/s
Electronic Tuning Range	40	55	40	60	Mc/s

APPLICATION

Mounting—The 1K015XA is provided with a three-hole base flange for solid mounting directly to the equipment chassis, to an insulating support or to the Eimac transition section to make the 1K015XG. No socket or tube clamp is necessary.

Cooling—No special provisions are ordinarily required for the cooling of the 1K015XA or 1K015XG. The resonator will dissipate 15 watts of power by radiation and convection in ambient temperatures up to 100°C.

Resonator—The resonator of the 1K015XA and 1K015XG is integral with the shell of the tube. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials. The coaxial output connection also lends itself to d-c isolation of the resonator from chassis potential. All voltages given in the list of Maximum Ratings and in the Typical Operation data are measured with respect to the cathode of the tube.

Cathode—Heater voltage should be at the rated value of 6.3 volts. Variations should be kept within the range of 5.7 to 6.9 volts. The cathode is internally connected to one side of the heater. If the resonator is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator potential.

▶ Indicates change from sheet dated 7-7-53

Repeller—There will be an optimum repeller voltage for any given output frequency, and the range of electronic tuning or frequency modulation under control of the repeller voltage will vary with output frequency and choice of repeller mode. These relations are shown for a typical tube in the accompanying curves.

Repeller voltages must be negative with respect to the cathode at all times.

▶ **Mechanical Tuning**—Mechanical tuning is accomplished by a single screw with a differential thread. Six full turns of the screw will tune the tube through a range of 800 Mc. The particular 800 Mc. range desired should be specified. Standard tuning range adjustment, unless otherwise specified, will be for 8600 to 9400 Mc.

Output—Curves illustrating the variation of power output with operating frequency for a typical tube are shown below. These curves assume a flat load and optimum repeller voltages at all frequencies. With a VSWR mismatch of 2 to 1, the power output will not fall below one-half the indicated power.

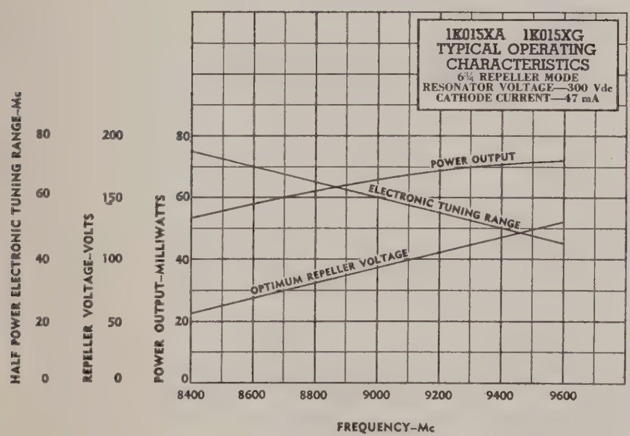
▶ **Frequency Stability**—Under axial vibration of 10g maximum acceleration, the spectrum width is less than 1.0 Mc. The frequency modulation response to vibration along other axes of the tube is approximately one-half that for the axial direction.

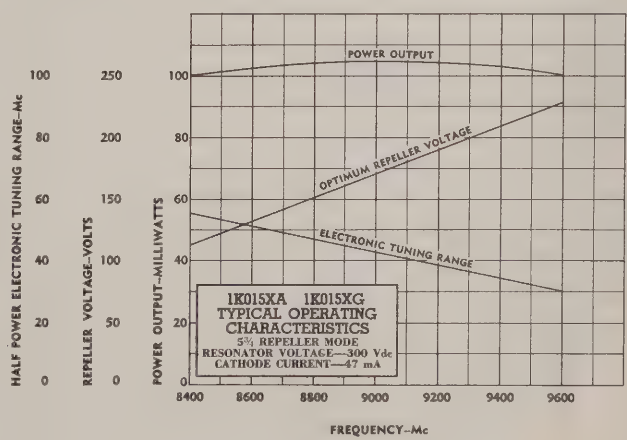
Frequency variations within the range of normal operating temperatures do not exceed ±0.1 Mc/°C.

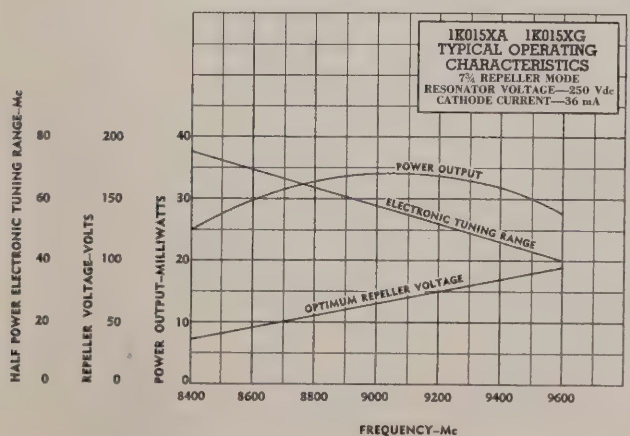
Starting Time—The 1K015XA and 1K015XG will be within ±10 Mc of operating frequency in less than one minute after applying voltages.

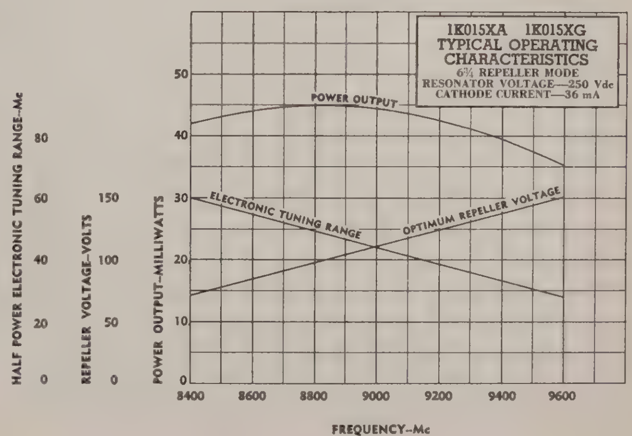
TYPICAL OPERATING CHARACTERISTICS 1K015XA AND 1K015XG

▶









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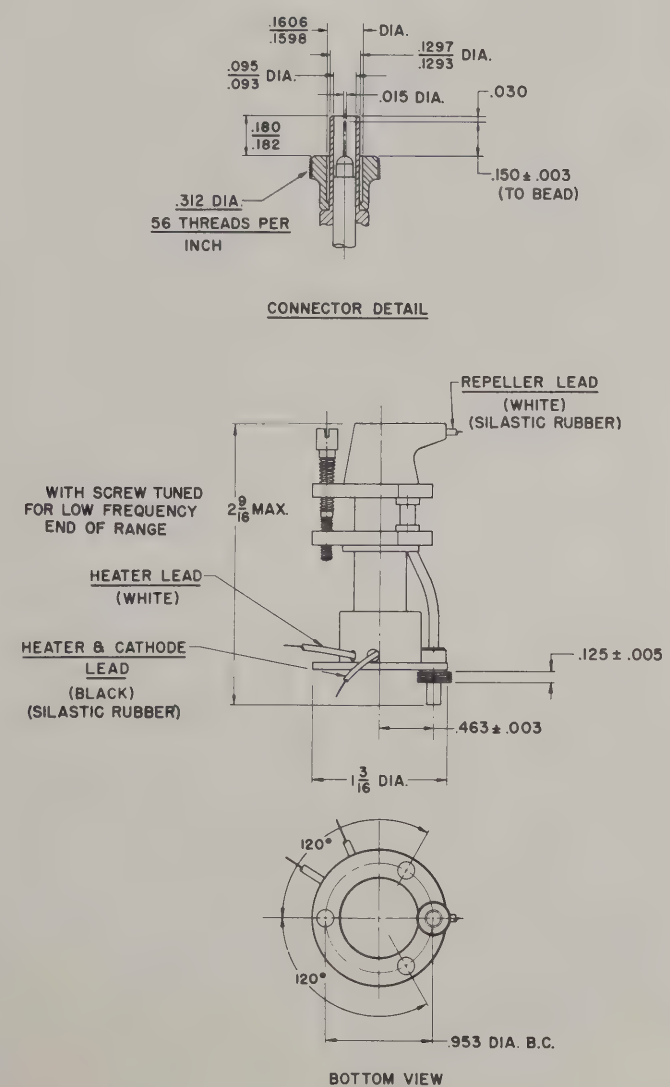
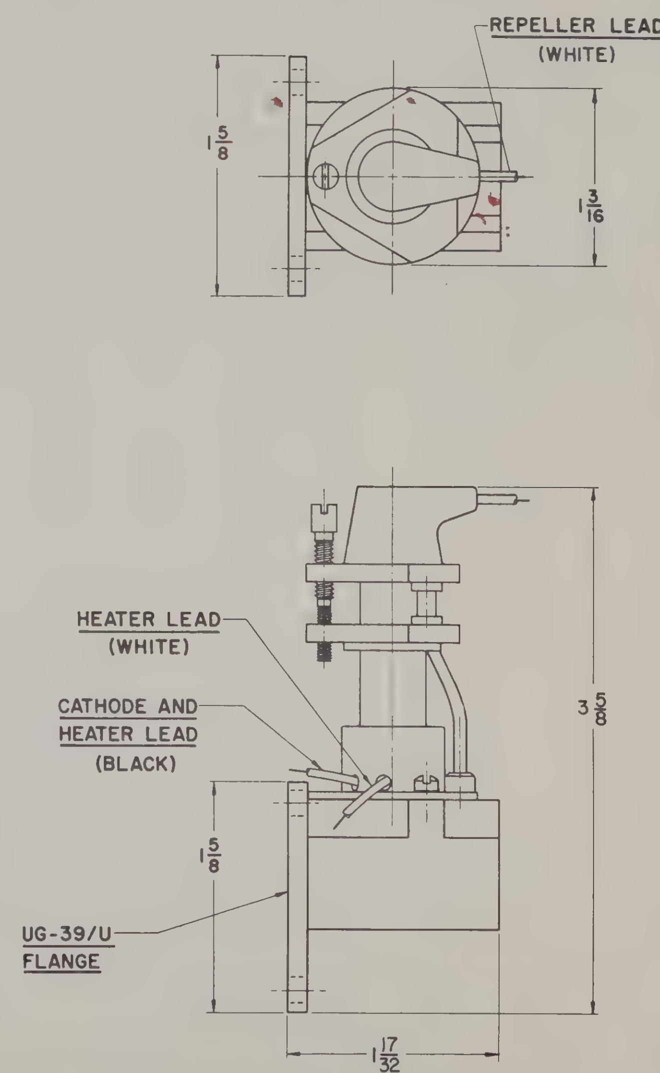


IK015XA (COAXIAL OUTPUT)



IK015XG (WAVEGUIDE OUTPUT)

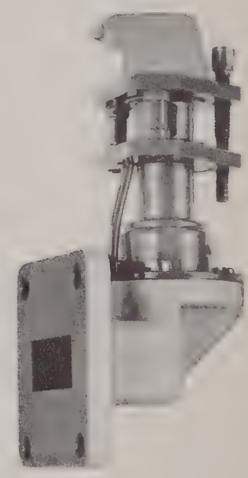
Printed in U.S.A. 2-4-81470

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

1K015XA AND 1K015XG KLYSTRONS

X-BAND OSCILLATORS

1K015XA
(Coaxial Output)



1K015XG
(Waveguide Output)

The EIMAC 1K015XA and 1K015XG are ruggedized, integral-cavity, X-band, reflex klystrons intended for local oscillator service under conditions of severe shock, vibration or sustained acceleration.

The 1K015X type tubes are available with either coaxial output or waveguide output. The r-f terminal of the 1K015XA is a coaxial connector. For waveguide output, the r-f terminal of the 1K015XG is the Eimac transition section.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Coated Unipotential

Heater Voltage - - - - - - -	6.3	volts
Heater Current - - - - - - -	0.80	amperes
Frequency Range - - - (8400 thru 9600 Mc)	900	Mc

(See paragraph: Mechanical Tuning in Application)

MECHANICAL

High Impact Shock* - - - - - - -	100	g
Axial Vibration Test (20-2000 cycles)* - - - -	10	g

Mounting (See Outline Drawing)
- 1K015XA: Three-hole flange and coaxial r-f terminal
- or
- 1K015XG: In conjunction with an Eimac transition section mounts directly on a UG-39/U waveguide flange

Connections:

Heater - - - - - - -	White wire at base
Heater and Cathode - - - -	Black wire at base
Resonator - - - - - - - -	Shell of tube
Repeller - - - - - - -	White wire at top

Output (See Outline Drawings)
- 1K015XA: Coaxial fitting,
- 1K015XG: UG-39/U waveguide flange

*The shock and vibration tests are applicable to both coaxial and waveguide outputs.

Indicates change from sheet dated 7-22-54

Mounting Position		Any
Cooling		Convection and Radiation
Maximum Over-all Dimensions:	Coaxial Output	Waveguide Output
Length	2-3/8 inches	3-9/16 inches
Diameter	1-3/16 inches	———
Width	———	1-15/32 inches
▶ Net Weight	1.5 ounces	3.2 ounces
Shipping Weight	4 ounces	8 ounces

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE	350 MAX. VOLTS
RESONATOR DISSIPATION	15 MAX. WATTS
D-C CATHODE CURRENT	50 MAX. MA
D-C REPELLER VOLTAGE	
Positive Limit	0 MAX. VOLTS
Negative Limit	500 MAX. VOLTS

TYPICAL OPERATION (With flat load)

Mode	6¾	7¾	5¾	6¾	
D-C Resonator Voltage	250	250	300	300	volts
D-C Cathode Current	36	36	47	47	mA
D-C Repeller Voltage	-110	-65	-170	-95	volts
Power Output	45	30	100	65	mW
Frequency	9000	9000	9000	9000	Mc/s
Electronic Tuning Range	40	55	40	60	Mc/s

APPLICATION

Mounting—The 1K015XA is provided with a three-hole base flange for solid mounting directly to the equipment chassis, to an insulating support or to the Eimac transition section to make the 1K015XG. No socket or tube clamp is necessary.

Cooling—No special provisions are ordinarily required for the cooling of the 1K015XA or 1K015XG. The resonator will dissipate 15 watts of power by radiation and convection in ambient temperatures up to 100°C.

Resonator—The resonator of the 1K015XA and 1K015XG is integral with the shell of the tube. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials. The coaxial output connection also lends itself to d-c isolation of the resonator from chassis potential. All voltages given in the list of Maximum Ratings and in the Typical Operation data are measured with respect to the cathode of the tube.

Cathode—Heater voltage should be at the rated value of 6.3 volts. Variations should be kept within the range of 5.7 to 6.9 volts. The cathode is internally connected to one side of the heater. If the resonator is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator potential.

▶ Indicates change from sheet dated 7-22-54

Repeller—There will be an optimum repeller voltage for any given output frequency, and the range of electronic tuning or frequency modulation under control of the repeller voltage will vary with output frequency and choice of repeller mode. These relations are shown for a typical tube in the accompanying curves.

Repeller voltages must be negative with respect to the cathode at all times.

▶ **Mechanical Tuning**—Mechanical tuning is accomplished by a single screw with a differential thread. The tuning rate is approximately 100 Mc. per turn. The particular range desired should be specified. Standard tuning range adjustment, unless otherwise specified, will be for 8600 to 9400 Mc.

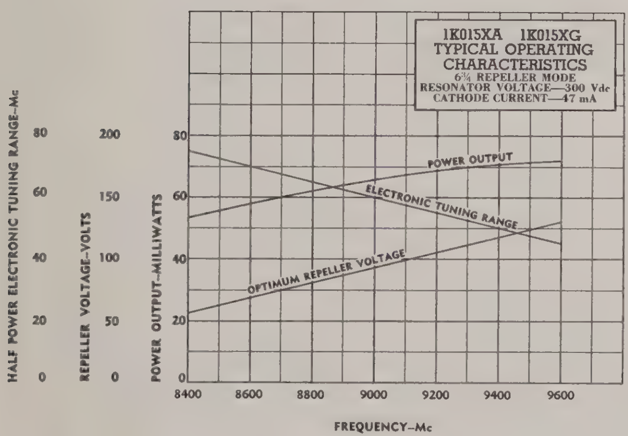
Output—Curves illustrating the variation of power output with operating frequency for a typical tube are shown below. These curves assume a flat load and optimum repeller voltages at all frequencies. With a VSWR mismatch of 2 to 1, the power output will not fall below one-half the indicated power.

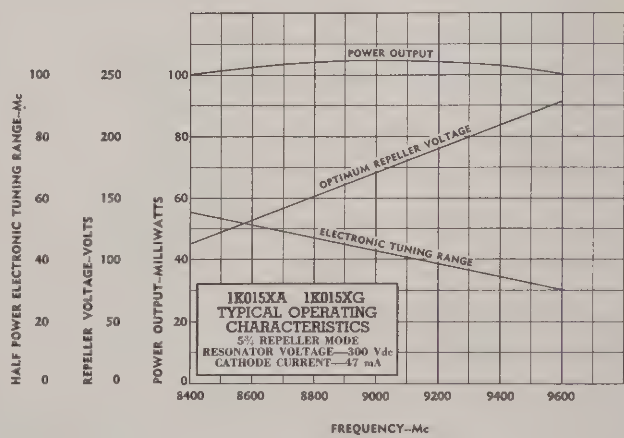
Frequency Stability—Under axial vibration of 10g maximum acceleration, the spectrum width is less than 1.0 Mc. The frequency modulation response to vibration along other axes of the tube is approximately one-half that for the axial direction.

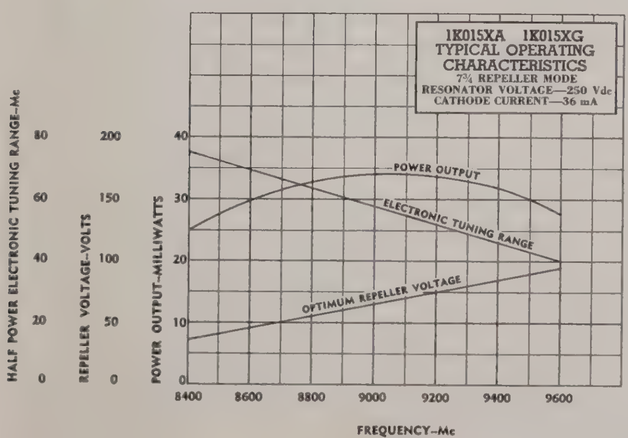
Frequency variations within the range of normal operating temperatures do not exceed ±0.1 Mc/°C.

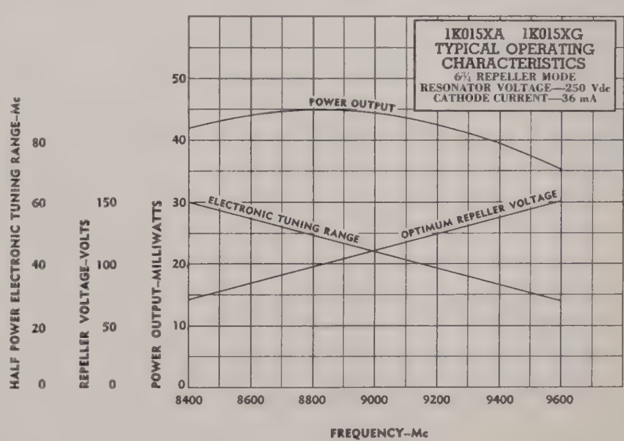
Starting Time—The 1K015XA and 1K015XG will be within ±10 Mc of operating frequency in less than one minute after applying voltages.

TYPICAL OPERATING CHARACTERISTICS 1K015XA AND 1K015XG









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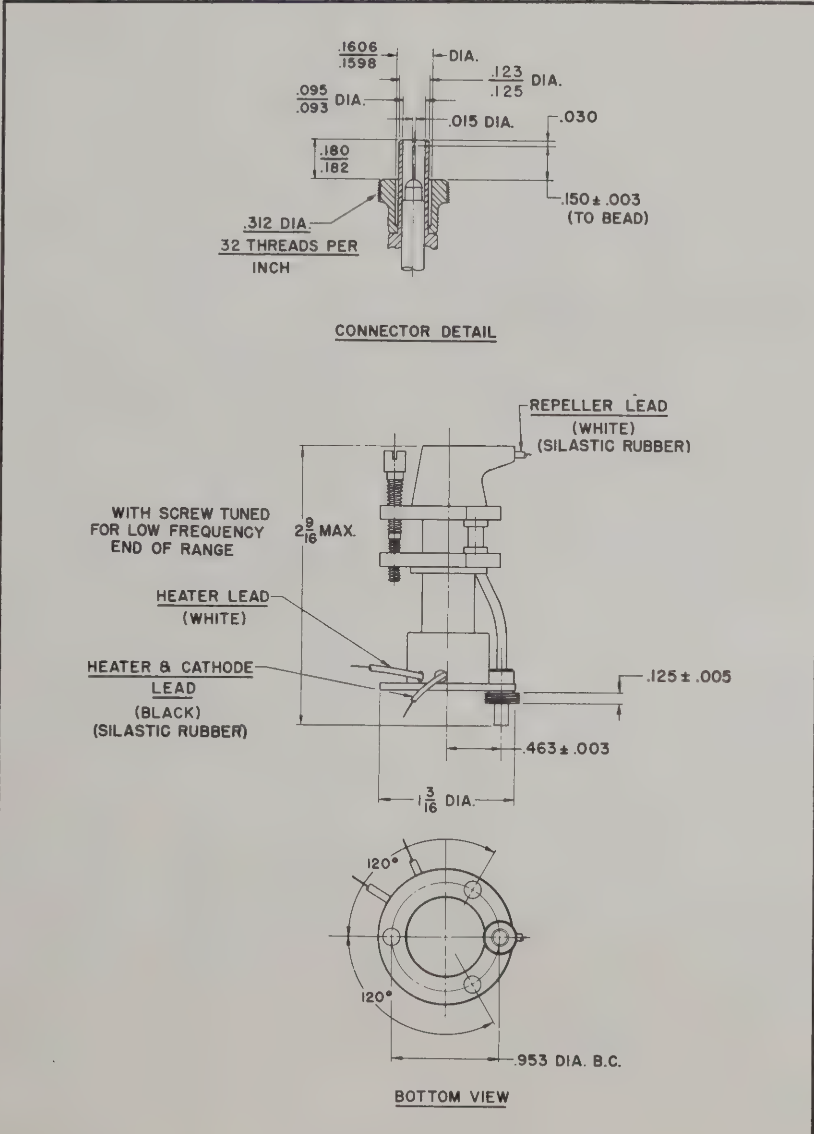
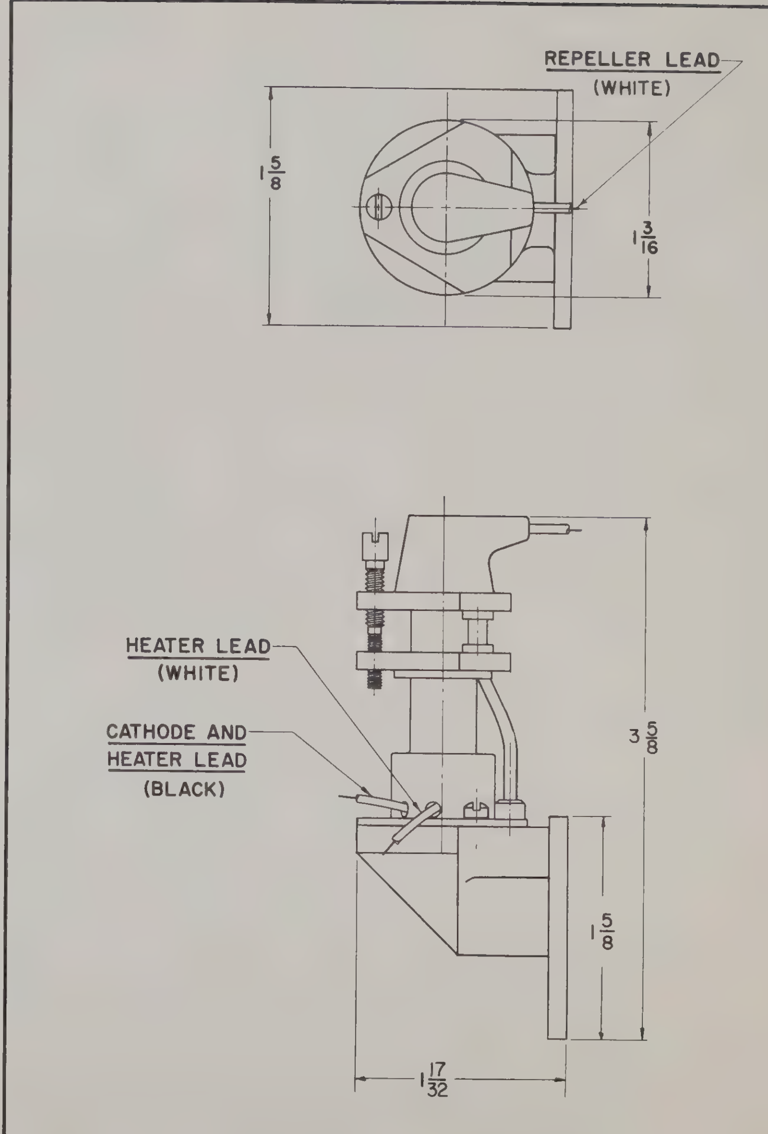


IK015XA (COAXIAL OUTPUT)



IK015XG (WAVEGUIDE OUTPUT)

Printed in U.S.A. 15099

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

3K2500LX

POWER-AMPLIFIER

L-BAND KLYSTRON

The Eimac 3K2500LX is a ceramic and metal, three cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 980 and 1200 megacycles. It will deliver a minimum CW output power of one kilowatt with a power gain of more than 25 db.

The resonant cavities of the 3K2500LX have cylindrical ceramic windows and are completed by tuning boxes external to the tube. This design permits a wide tuning range, and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-114) has been designed for use with this tube. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated	
	Minimum Heating Time	5 minutes
Heater:	Voltage	7.5 volts
	Current	5.8 amperes
	Maximum Starting Current	15 amperes
Power Gain		25 db
Output Power		1000 watts
Frequency Range		980 to 1200 mc

MECHANICAL

Operating Position*		Axis vertical
R-F Coupling:		
	Input	Type "N" coaxial fitting
	Output	1 5/8-inch 50-ohm air line
Cooling (See Application)		Forced air
Net Weight		22 pounds
Shipping Weight (Approximate)		80 pounds
Maximum Over-All Dimensions:		
	Length	25 7/8 inches
	Diameter	5 1/8 inches

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-114 Coils)

Prefocus-Coil Voltage	0 to 35	volts
Prefocus-Coil Current	0 to 1.0	ampere
Body-Coil Voltage	0 to 165	volts
Body-Coil Current	0 to 2.5	amperes

*Cathode end up when installed in the Eimac H-114 circuit assembly.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	7000 MAX. VOLTS
D-C BEAM CURRENT	600 MAX. MA
D-C BODY CURRENT (CONTINUOUS)	60 MAX. MA
D-C BODY CURRENT (TUNING ONLY)	90 MAX. MA
D-C FOCUS-ELECTRODE VOLTAGE	-100 MAX. VOLTS
COLLECTOR DISSIPATION	2500 MAX. WATTS

TYPICAL OPERATION

NARROW-BAND CW AMPLIFIER (In H-114 Circuit Assembly)

Frequency	1000	1000	megacycles
Output Power	830	1320	watts
Driving Power	2	2	watts
Power Gain	26.1	28.2	db
D-C Beam Voltage	6000	7000	volts
D-C Beam Current	350	455	milliamperes
Beam Input Power	2100	3180	watts
Beam Power Efficiency	39.5	41.4	percent
D-C Body Current	40	30	milliamperes
D-C Collector Current	310	425	milliamperes
Collector Dissipation*	1030	1650	watts
Focus-Electrode Voltage	-100	-100	volts
Heater Voltage	7.5	7.5	volts
Heater Current	5.8	5.8	amperes
Magnetic-Coil Currents:*			
Prefocus	0.5	0.5	ampere
Body	2.0	2.0	amperes

*Approximate values.

APPLICATION

Cooling--When the 3K2500LX is operated at sea level, with an ambient air temperature of less than 30° C (86°F), the cathode will normally require only convection air cooling. At higher altitudes or temperatures, forced-air cooling must be used to maintain the temperature of the metal button at the cathode end of the tube below 150°C.

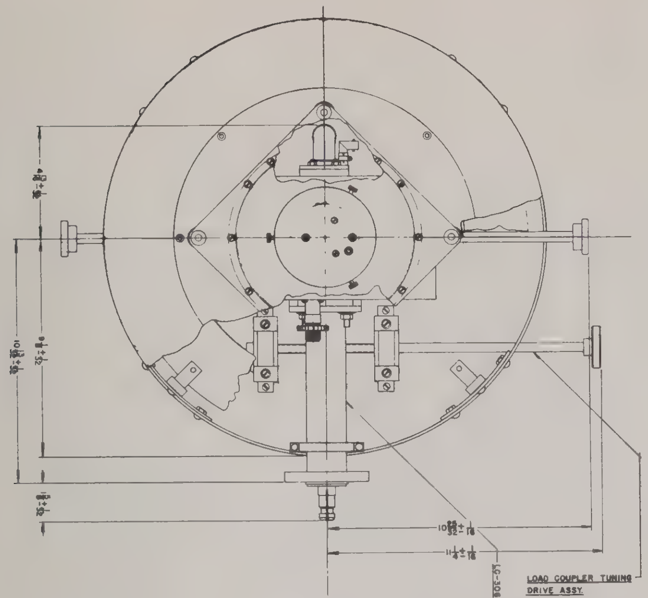
With a maximum ambient temperature of 25° C (77° F) and at sea level, the air-flow rates tabulated below are sufficient for operation at maximum ratings.

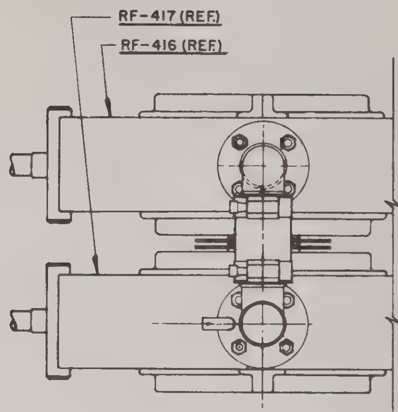
Output and Middle Cavities (Combined)	50 cfm
Collector	150 cfm

At higher temperatures or altitudes, the air-flow rate must be increased to obtain equivalent cooling.

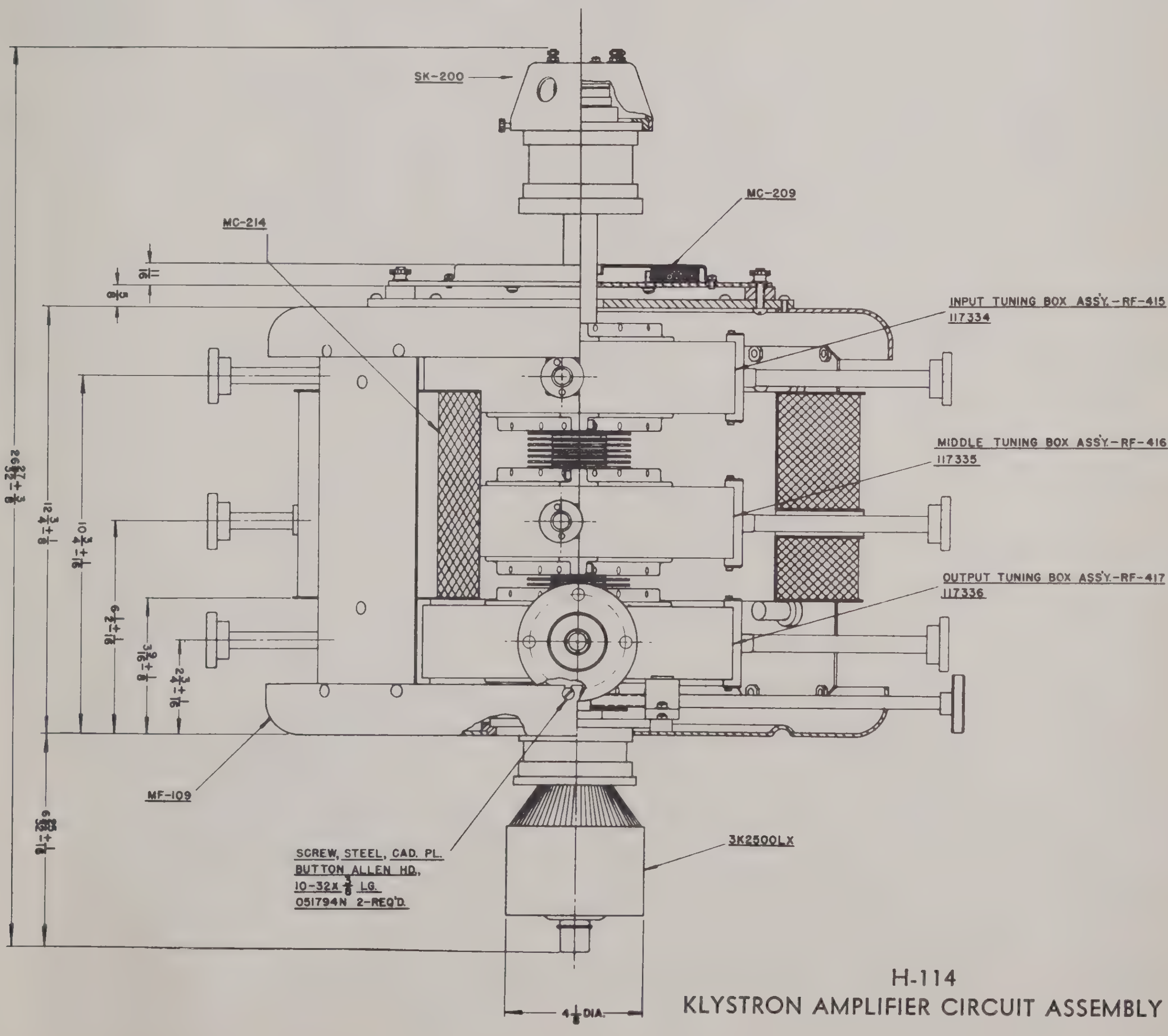
Body cooling is normally provided by the escaping air from the tuning boxes. However, if the ambient air temperature exceeds 30° C, forced air will also be required on the body cooling fins.

Special Applications--If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California.





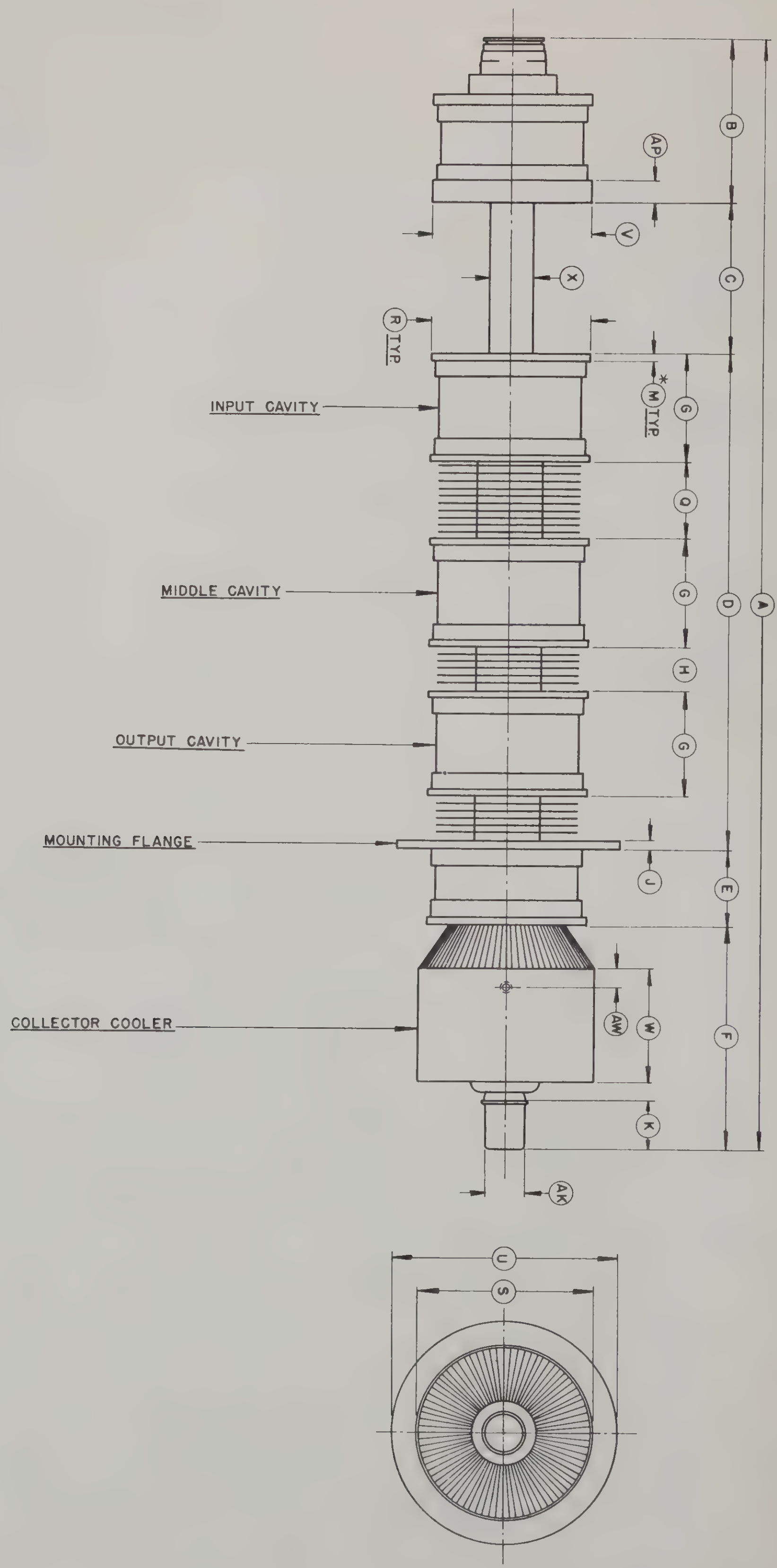
DETAIL SHOWING COOLING TUBE ASSY.



H-114

KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		25.438	26.188
B		3.730	3.980
C		3.406	3.470
D		11.107	11.357
E	1.976		
F		5.187	5.437
G		2.464	2.528
H		.971	1.033
J		.220	.240
K		1.115	1.135
M		.187	
Q		1.710	1.774
R		3.615 DIA.	3.635 DIA.
S		3.985 DIA.	4.015 DIA.
U		5.118 DIA.	5.148 DIA.
V		3.615 DIA.	3.635 DIA.
W	2.625		
X		.992 DIA.	1.008 DIA.
AK		.865 DIA.	.885 DIA.
AP		.490	.510
AW		.428	.448



NOTES:
1. * MINIMUM CONTACT SURFACES.
2. DIMENSIONS IN INCHES

3K2500LX
OUTLINE DRAWING

Printed in U.S.A. 54405

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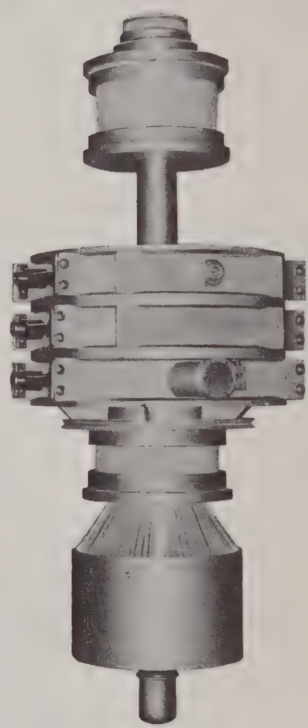
EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

3K2500SG

POWER-AMPLIFIER S-BAND KLYSTRON



The Eimac 3K2500SG is a ceramic and metal, three-cavity, magnetically focused, power-amplifier klystron designed primarily for communication service in the frequency range of 1700 to 2400 megacycles. It will deliver a minimum CW output power of one kilowatt throughout this range with a power gain of 25 db.

The resonant cavities of the 3K2500SG are an integral part of the tube structure and are completed and tuned outside the vacuum envelope. This design allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-113) has been designed for use with this tube type. This assembly includes an electromagnetic frame and coils, an adjustable load coupler, an air manifold, and an Eimac SK-200 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	7.5 volts
Current	5.5 amperes
Output Power	1000 watts
Power Gain	25 db
Frequency Range	1700 to 2400 mc

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-113 Circuit Assembly)

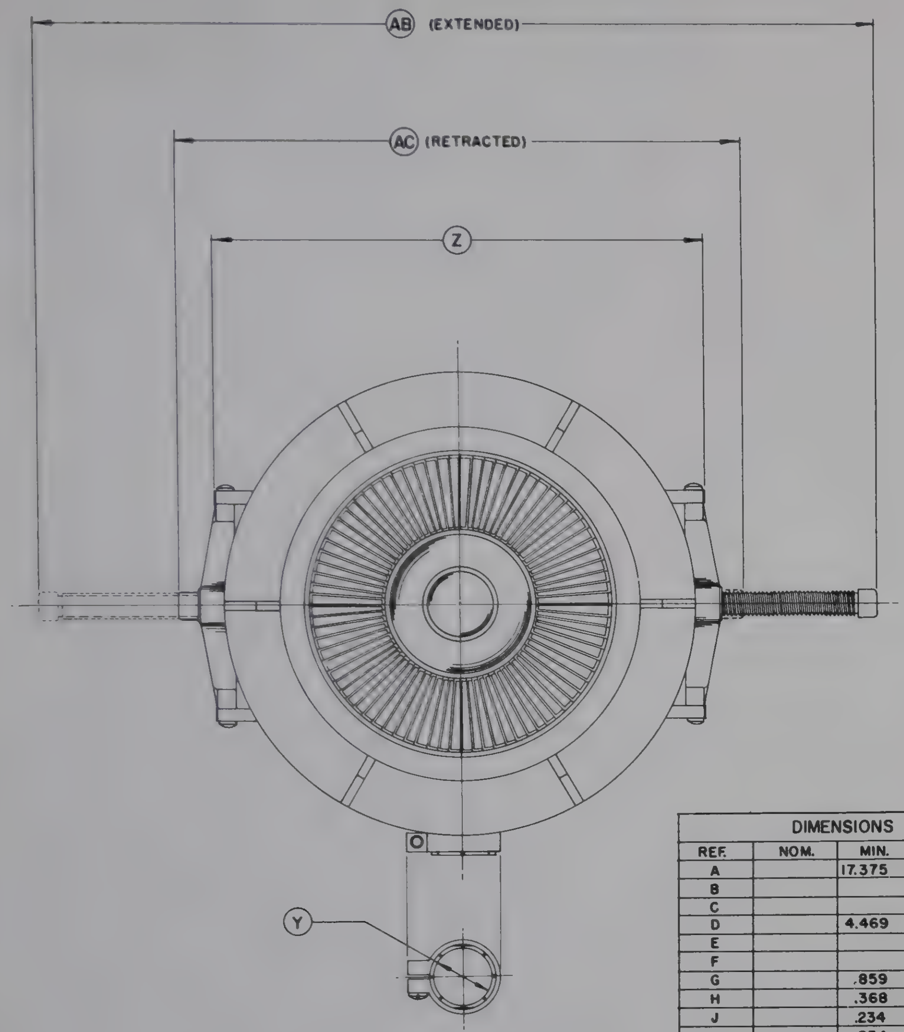
Prefocus-Coil Voltage	0 to 25 volts
Prefocus-Coil Current	0 to 1 ampere
Body-Coil Voltage	50 to 100 volts
Body-Coil Current	2 to 4 amperes
Collector-Coil Voltage	0 to 10 volts
Collector-Coil Current	0 to 3 amperes

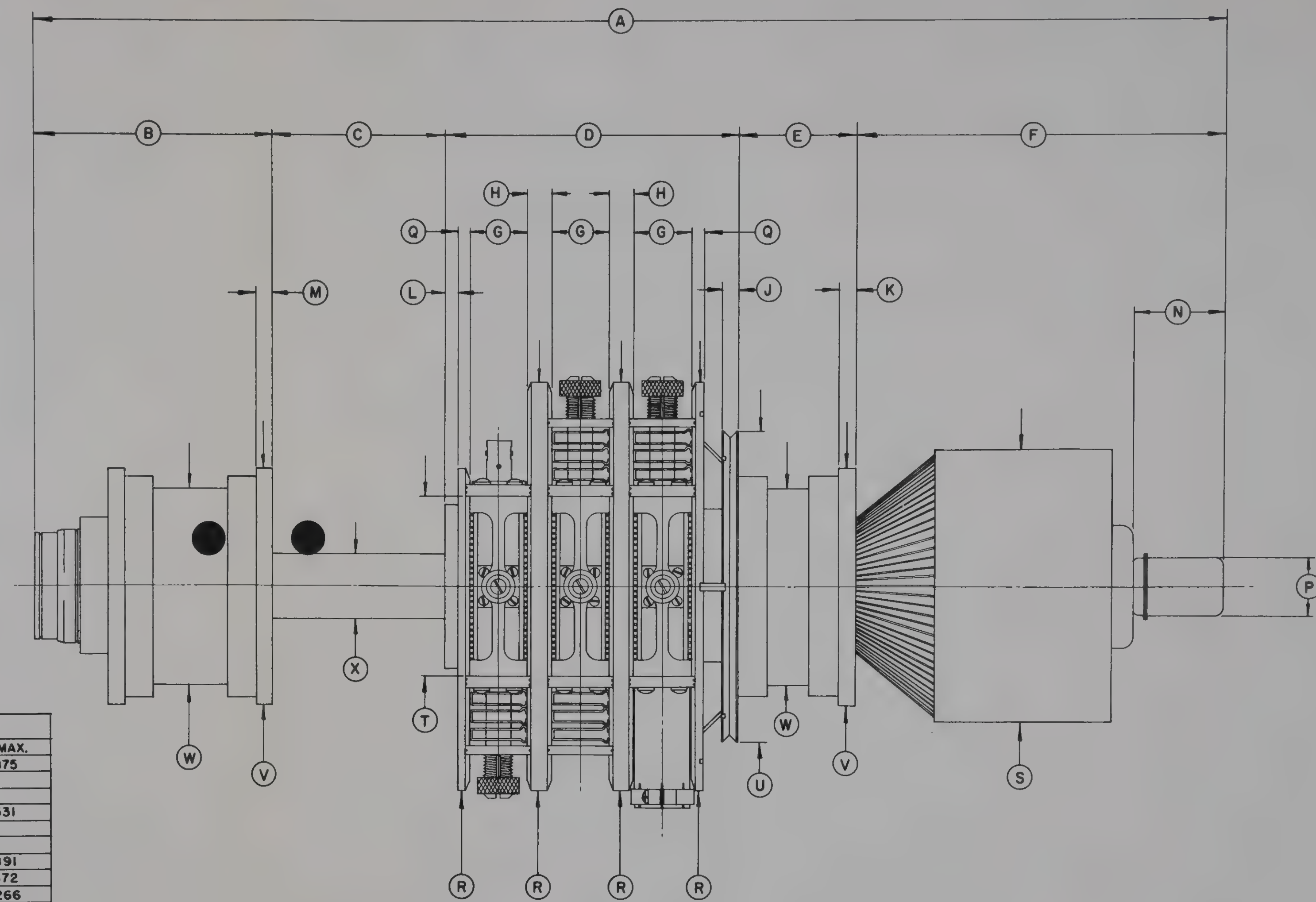
MECHANICAL

Operating Position*	Axis vertical
Recommended Socket	Eimac SK-200
R-F Coupling:	
Input	BNC
Output (From load coupler)	RETMA 1 5/8-inch 50-ohm air line
Cooling (See back page)	Forced air
Net Weights:	
Tube Only	28 pounds
Tube and Circuit Assembly	143 pounds
Shipping Weights: (Approximate)	
Tube Only	130 pounds
Circuit Assembly Only	145 pounds

* Cathode end up when installed in Eimac H-113 Circuit Assembly.

3K2500SG





DIMENSIONS			
REF.	NOM.	MIN.	MAX.
A		17.375	17.875
B			
C			
D		4.469	4.531
E			
F			
G		.859	.891
H		.368	.372
J		.234	.266
K		.234	.266
L			
M		.245	.255
N			
P		.859 DIA.	.891 DIA.
Q		.173	.177
R		6.234 DIA.	6.266 DIA.
S		4.109 DIA.	4.141 DIA.
T		2.745	2.755
U		4.734 DIA.	4.766 DIA.
V		3.609 DIA.	3.641 DIA.
W		2.998 DIA.	3.002 DIA.
X		.969 DIA.	1.000 DIA.
Y		.745 I.D.	.755 I.D.
Z		6.495	6.505
AB	10 9/16		
AC	7 9/16		

3K2500SG

OUTLINE DRAWING

(TENTATIVE)

COOLING

The cathode of the 3K2500SG requires no forced-air cooling if operated under conditions where the ambient air temperature is 30° C or less. In installations where the ambient air temperature exceeds 30° C, enough air must be used to maintain the temperature of the metal button at the cathode end of the tube below 150° C. A short piece of 3/8-inch tubing, bleeding air from the drift-tube air-supply inlet tube and directed at the cathode button, will ordinarily supply sufficient cooling.

With an ambient air temperature of 30° C and at sea level, minimum air-flow requirements and approximate pressure drops for the drift tubes and collector cooler are:

	Flow Rate	Pressure Drop
Drift Tubes	100 cfm	2.3 inches H_2O
Collector	100 cfm	1.5 inches H_2O

NOTE: Since some of the air used to cool the drift tubes is channeled through the r-f cavities by means of screened doors, the air supply must be well filtered to avoid the deposit of dirt and metal particles within the cavities.

MAXIMUM RATINGS

D-C BEAM VOLTAGE - - - - - -	7000 MAX. VOLTS
D-C BEAM CURRENT - - - - - -	600 MAX. MA
D-C BODY CURRENT (CONTINUOUS) - - - -	60 MAX. MA
D-C BODY CURRENT (TUNING ONLY) - - - -	90 MAX. MA
FOCUS-ELECTRODE VOLTAGE - - - - -	-100 MAX. VOLTS
COLLECTOR DISSIPATION - - - - -	2500 MAX. WATTS

TYPICAL OPERATION In Eimac H-113 Circuit Assembly

Frequency - - - - - -	1700	2400	megacycles
Output Power - - - - -	1.35	1.3	kilowatts
Driving Power - - - - -	4	4	watts
Power Gain - - - - - -	25	25	db
D-C Beam Voltage - - - - -	7	7	kilovolts
D-C Beam Current - - - - -	570	570	milliamperes
Beam Input Power - - - - -	4	4	kilowatts
Beam Power Efficiency - - -	33.8	30.7	percent
D-C Body Current - - - - -	30	50	milliamperes
D-C Collector Current - - -	540	520	milliamperes
Focus-Electrode Voltage - - -	0	0	volts
Heater Voltage - - - - -	7.5	7.5	volts
Heater Current - - - - -	5.5	5.5	amperes
Prefocus-Coil Voltage - - -	14	14	volts
Prefocus-Coil Current - - -	0.4	0.4	ampere
Body-Coil Voltage - - - - -	77	77	volts
Body-Coil Current - - - - -	3.5	3.5	amperes
Collector-Coil Voltage - - -	6	6	volts
Collector-Coil Current - - -	1.5	1.5	amperes

APPLICATION

If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California.

Printed in U.S.A. 45270

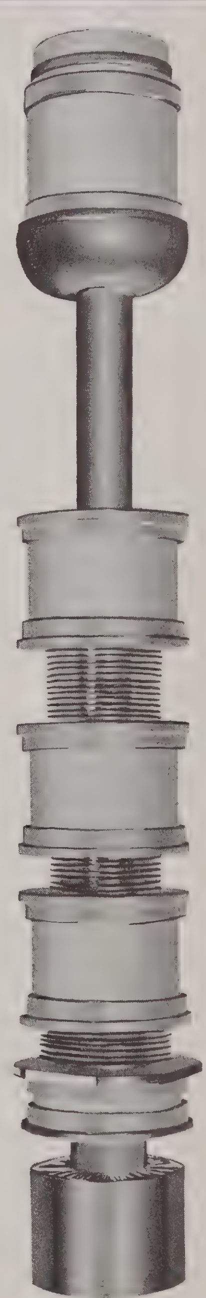
TENTATIVE DATA

3K3000LQ

POWER-AMPLIFIER L-BAND KLYSTRON

Eimac®

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA



The Eimac 3K3000LQ is a ceramic and metal, three-cavity magnetically focused, power-amplifier klystron designed for use at frequencies between 610 and 985 megacycles. It will deliver a minimum CW output power of two kilowatts with a power gain of more than 25 db.

The resonant cavities for the 3K3000LQ are completed through the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-102) has been designed for use with this tube and covers the frequency range of 720 to 985 megacycles. Other frequency ranges can be provided if required. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated	
	Minimum Heating Time	5 minutes
Heater:	Voltage	5.0 volts
	Current	31 amperes
	Maximum Starting Current	60 amperes
Power Gain		25 db
Output Power		2000 watts
Frequency Range (In H-102 Assembly)		720 to 985 mc

MECHANICAL

Operating Position*		Axis vertical
R-F Coupling:		
	Input	Type "N" coaxial fitting
	Output	1 5/8-inch 50-ohm air line
Net Weight		32 pounds
Shipping Weight (Approximate)		115 pounds
Maximum Over-All Dimensions:		
	Length	34 1/8 inches
	Diameter	5 1/8 inches

*Cathode end up when installed in H-102 circuit assembly.

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-102 Coils)

Prefocus-Coil Voltage		0 to 50 volts
Prefocus-Coil Current		0 to 1.5 amperes
Each of Two Body Coils:**		
	Voltage	0 to 150 volts
	Current	0 to 2.5 amperes

**These coils may be operated series connected with a slight decrease in beam efficiency.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	9000	MAX.	VOLTS
D-C BEAM CURRENT	750	MAX.	MA
D-C BODY CURRENT (CONTINUOUS)	75	MAX.	MA
D-C BODY CURRENT (TUNING ONLY)	100	MAX.	MA
D-C FOCUS-ELECTRODE VOLTAGE	-500	MAX.	VOLTS
COLLECTION DISSIPATION	3000	MAX.	WATTS

TYPICAL OPERATION

NARROW-BAND CW AMPLIFIER (In H-102 Circuit Assembly)

Frequency	850	850	megacycles
Output Power	1300	2790	watts
Driving Power	4	10	watts
Power Gain	25.1	24.4	db
D-C Beam Voltage	7000	9000	volts
D-C Beam Current	375	580	milliamperes
Beam Input Power	2625	5220	watts
Beam Power Efficiency	49.5	53.5	percent
D-C Body Current	30	30	milliamperes
D-C Collector Current	345	550	milliamperes
Collector Dissipation*	1535	2160	watts
Focus-Electrode Voltage	-200	-200	volts
Filament Voltage	5.0	5.0	volts
Filament Current	31	31	amperes
Magnetic-Coil Currents:*			
Prefocus	0.48	0.5	ampere
First Body	2.3	2.3	amperes
Second Body	1.6	2.15	amperes

*Approximate values.

APPLICATION

Cooling--The 3K3000LQ is cooled by forced air. At sea level and with an inlet air temperature of 20° C (68° F), the flow rates tabulated below are sufficient for operation at maximum ratings. Corresponding pressure drops, in inches of water column, are also listed to allow the effective measurement of air flow in the field without elaborate test equipment.

Cathode (With SK-100 Socket)	5 cfm	0.4 inch H^2O
Output Cavity	50 cfm	1.0 inch H^2O
Collector	150 cfm	1.6 inches H^2O

Operation at higher altitudes or with higher inlet air temperatures requires increased volumes of air flow to obtain equivalent cooling.

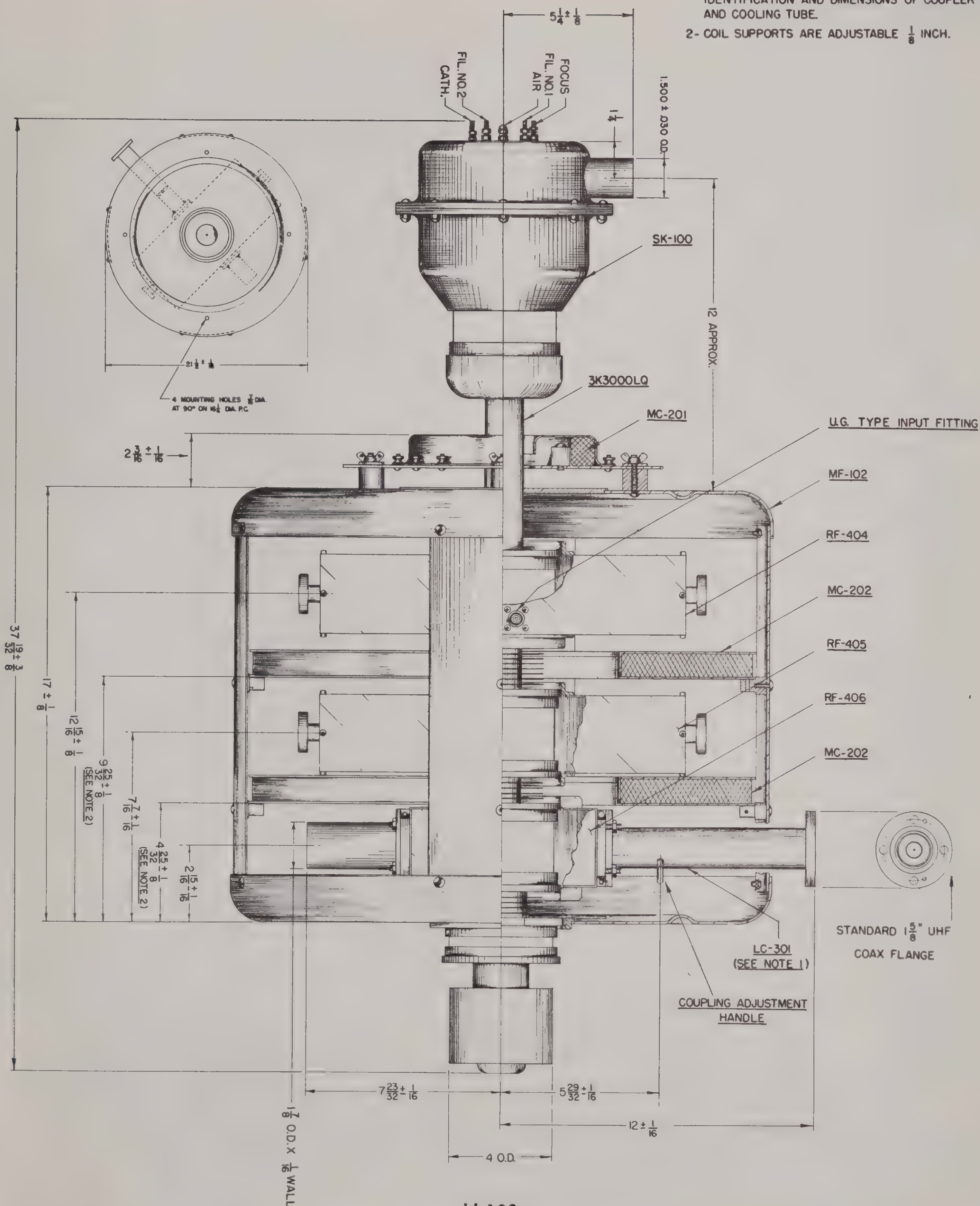
Since the collector dissipation rating of the 3K3000LQ may be exceeded in the event of a loss of driving power, the collector should be fitted with a thermal overload for maximum protection. This device should be set to operate at 175° C and installed in the beam-voltage supply circuit. The sensing element for this overload should be located on the input section of the collector body at the point indicated on the outline drawing.

Special Applications--If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California.

NOTES:

1- THIS BOX IS SHOWN ROTATED 90° FOR PARTS IDENTIFICATION AND DIMENSIONS OF COUPLER AND COOLING TUBE.

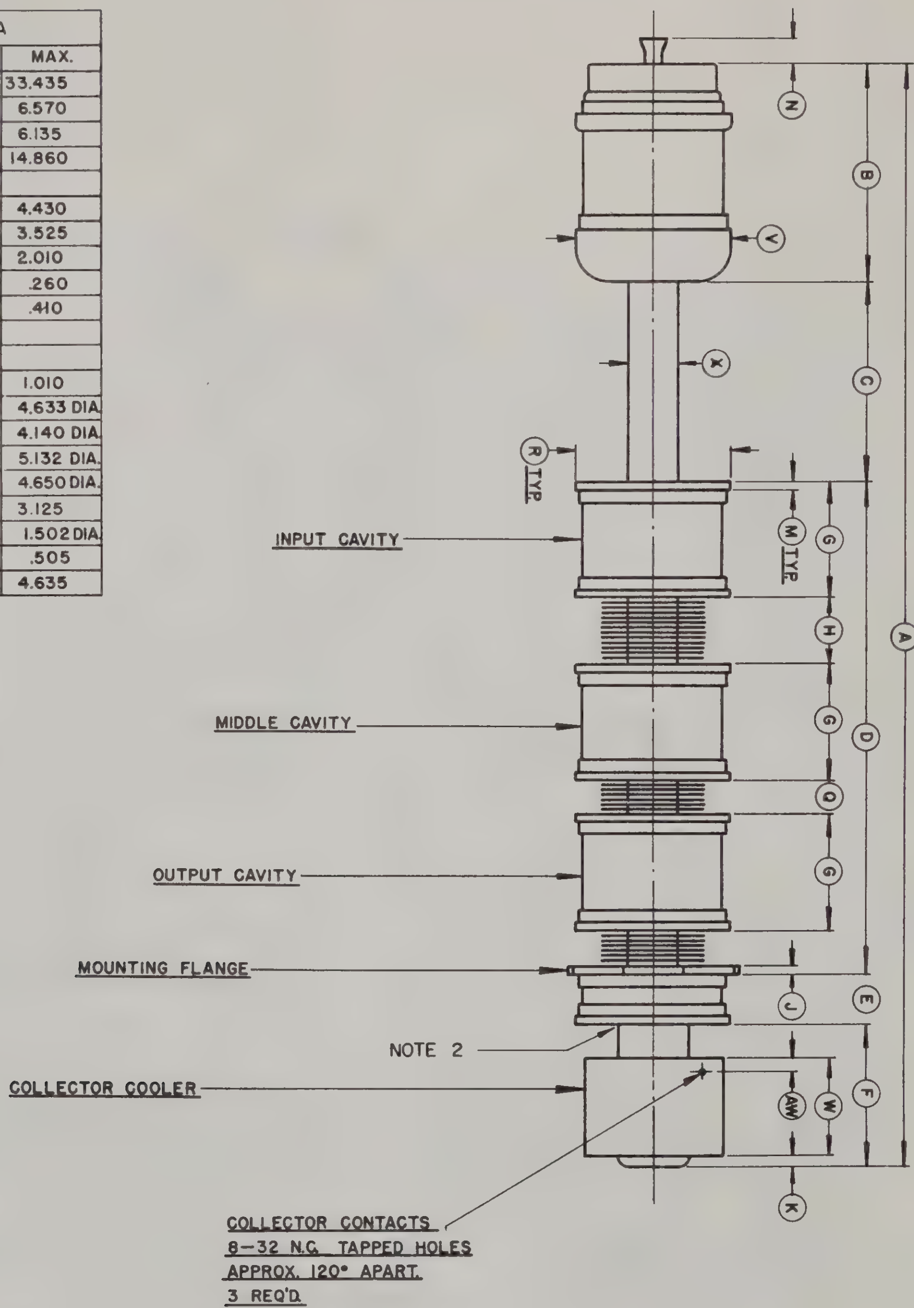
2- COIL SUPPORTS ARE ADJUSTABLE $\frac{1}{8}$ INCH.



H-102

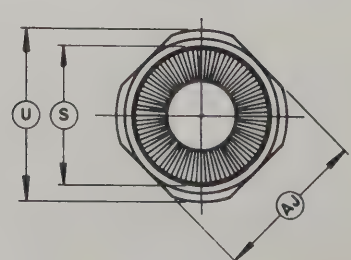
KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

DIMENSION DATA			
REF.	NOM	MIN.	MAX.
A		33.120	33.435
B		6.495	6.570
C		5.995	6.135
D		14.810	14.860
E	1.510		
F		4.360	4.430
G		3.495	3.525
H		1.985	2.010
J		.235	.260
K		.375	.410
M		.187	
N	.750		
Q		.980	1.010
R		4.618 DIA.	4.633 DIA.
S		4.125 DIA.	4.140 DIA.
U		5.118 DIA.	5.132 DIA.
V		4.615 DIA.	4.650 DIA.
W		2.950	3.125
X		1.490 DIA.	1.502 DIA.
AW		.405	.505
AJ		4.618	4.635



NOTES:

1. DIMENSIONS IN INCHES
2. LOCATE THERMAL-OVERLOAD SENSING ELEMENT HERE.



3K3000LQ
OUTLINE DRAWING

Printed in U.S.A. 47459

Eimac®

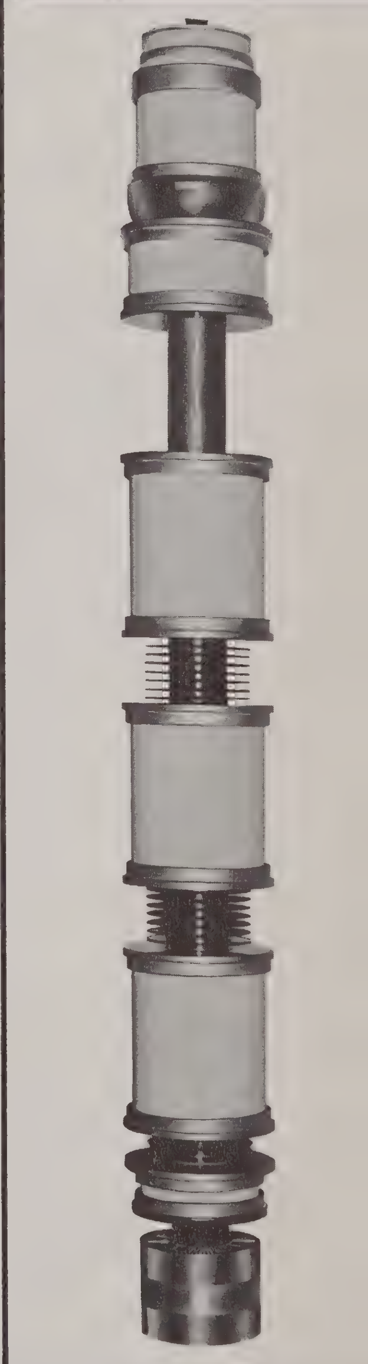
EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

3KM3000LA

POWER-AMPLIFIER

L-BAND KLYSTRON



The Eimac 3KM3000LA is a ceramic and metal, three-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 375 and 585 megacycles. It will deliver two kilowatts CW, one kilowatt AM carrier, or 20 kilowatts pulse output power.

This klystron employs the Eimac modulating anode which provides an effective method of amplitude or pulse modulating the output power without changing beam voltage.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-120) has been designed for use with the 3KM3000LA and covers the range of 385 to 580 megacycles. Other frequency ranges can be provided if required. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated		
	Minimum Heating Time	5	minutes
Heater:	Voltage	5	volts
	Current	31	amperes
	Maximum Starting Current	60	amperes
Modulating-Anode Capacitance			
	(To all other electrodes)	21	uuf
Power Gain (Narrow-Band CW)		30	db
Output Power (Narrow-Band CW)		2000	watts
Frequency Range (In H-120 Assembly)		385 to 580	mc

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (H-120 Components)

Prefocus-Coil Voltage		0 to 50	volts
Prefocus-Coil Current		0 to 1.5	amperes
Each of Two Body Coils:			
	Voltage	0 to 175	volts
	Current	0 to 3	amperes
Collector-Coil Voltage		0 to 50	volts
Collector-Coil Current		0 to 1.5	amperes

MECHANICAL

Operating Position*	Axis vertical
R-F Input Coupling	Type "N" coaxial fitting
R-F Output Coupling	1 5/8-inch 50-ohm air line
Net Weight	46 pounds
Shipping Weight (Approximate)	130 pounds

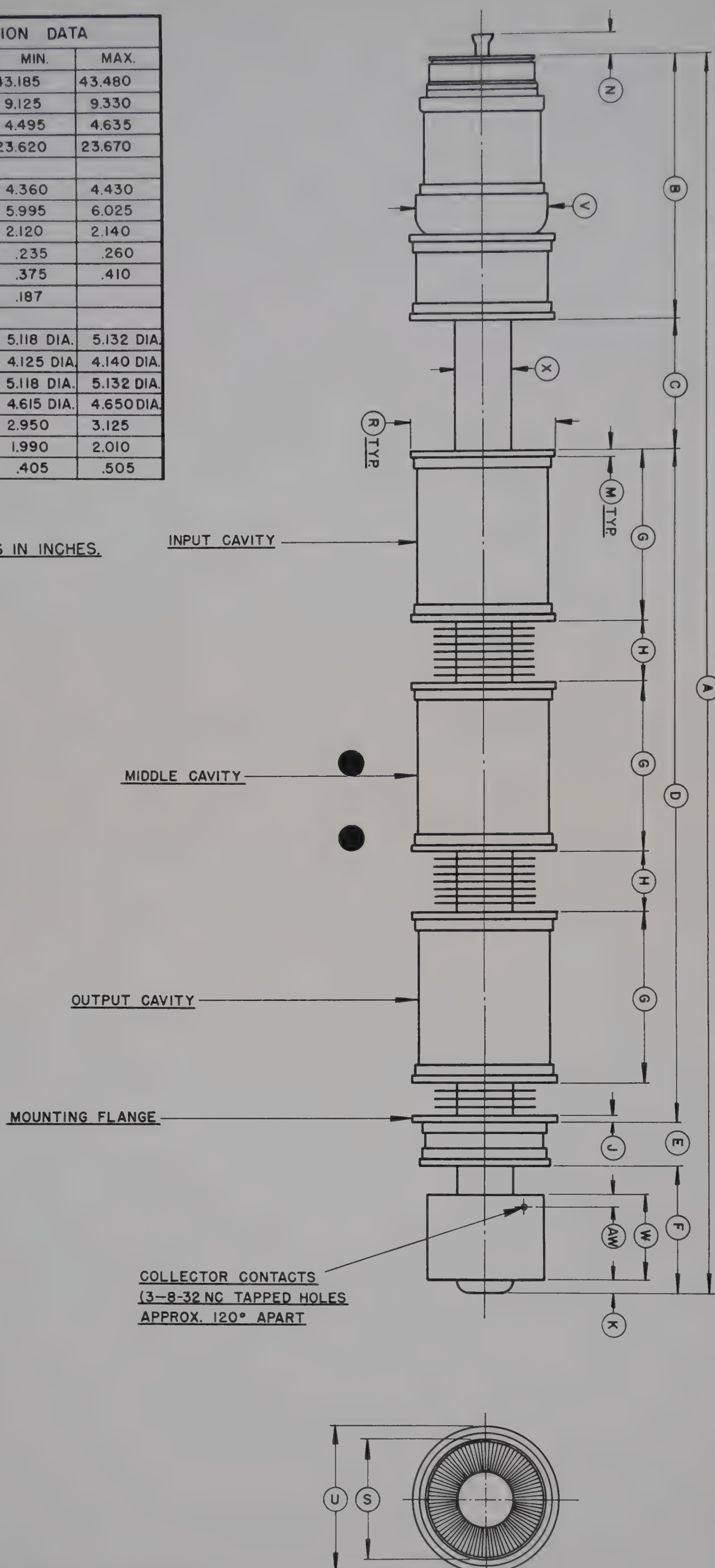
Cooling for Operation at Maximum Ratings:	Flow Rate	Pressure Drop
Cathode (With Eimac SK-100 Socket)	5 cfm air	0.4 inch H_2O
Output Cavity	50 cfm air	1.0 inch H_2O
Collector	150 cfm air	1.6 inches H_2O

*Cathode end up when installed in H-120 circuit assembly.

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		43.185	43.480
B		9.125	9.330
C		4.495	4.635
D		23.620	23.670
E	1.510		
F		4.360	4.430
G		5.995	6.025
H		2.120	2.140
J		.235	.260
K		.375	.410
M		.187	
N	.750		
R		5.118 DIA.	5.132 DIA.
S		4.125 DIA.	4.140 DIA.
U		5.118 DIA.	5.132 DIA.
V		4.615 DIA.	4.650 DIA.
W		2.950	3.125
X		1.990	2.010
AW		.405	.505

NOTES:

1. DIMENSIONS IN INCHES.



3KM3000LA OUTLINE DRAWING

3KM3000LA

MAXIMUM RATINGS

D-C BEAM VOLTAGE (PULSE OPERATION)	20 MAX. KILOVOLTS
D-C BEAM VOLTAGE (CW OPERATION)	9 MAX. KILOVOLTS
PEAK D-C BEAM CURRENT	2.8 MAX. AMPERES
AVERAGE D-C BEAM CURRENT	750 MAX. MA
D-C BODY CURRENT (CONTINUOUS)	75 MAX. MA
D-C BODY CURRENT (TUNING ONLY)	100 MAX. MA
D-C FOCUS-ELECTRODE VOLTAGE	-500 MAX. VOLTS
COLLECTOR DISSIPATION	3 MAX. KILOWATTS

TYPICAL OPERATION
(In H-120 Circuit Assembly)

NARROW-BAND PULSE AMPLIFIER, 400-450 MEGACYCLES, 0.06 DUTY, MODULATING ANODE PULSED

Peak Output Power	12.25	kilowatts
Peak Driving Power	10	watts
Peak Power Gain	30.9	db
D-C Beam Voltage	15	kilovolts
Peak D-C Beam Current	1.74	amperes
Peak D-C Beam Input Power	26.2	kilowatts
Beam Power Efficiency	47	percent
Peak D-C Body Current	100	milliamperes
Peak D-C Collector Current	1.64	amperes
Peak D-C Modulating-Anode Voltage	15	kilovolts
Focus-Electrode Voltage	0	volts
Magnetic-Coil Currents:*		
Prefocus	1.0	ampere
First Body	2.7	amperes
Second Body	2.7	amperes
Collector	1.5	amperes

NARROW-BAND CW AMPLIFIER, 520 MEGACYCLES

Output Power	0.9	2.3	kilowatts
Driving Power	1	2	watts
Power Gain	29.5	30	db
D-C Beam Voltage	6	9	kilovolts
D-C Beam Current	370	590	milliamperes
Beam Input Power	2.58	5.3	kilowatts
Beam Power Efficiency	40.5	43.4	percent
D-C Body Current	25	40	milliamperes
D-C Collector Current	345	550	milliamperes
Focus-Electrode Voltage	-200	-200	volts
Magnetic-Coil Currents:*			
Prefocus	0.65	0.7	ampere
First Body	2.0	2.0	amperes
Second Body	1.1	1.6	amperes
Collector	1.0	1.0	ampere

*Approximate values.

APPLICATION

If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California.

Printed in U.S.A. 47459

TENTATIVE DATA

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

3K50,000LA
3K50,000LF
3K50,000LK
KLYSTRONS

L-BAND AMPLIFIERS

The Eimac 3K50,000LA, 3K50,000LF and 3K50,000LK klystrons are three cavity, magnetically focused power amplifiers intended primarily for UHF television broadcast service. Each klystron type, operating as a television visual r-f amplifier, will deliver 12 kW of peak synchronizing power output with a power gain of approximately 20 db. The cavities of the Eimac UHF television klystrons have ceramic windows and are completed by tuning boxes external to the tubes.

NOMINAL TUNING RANGE

The UHF television band (470-890 Mc) is covered by the three tube types as follows:

TUBE TYPE NUMBER	MC.	CHANNEL
3K50,000LA	470-580	14-32
3K50,000LF	580-720	33-55
3K50,000LK	720-890	56-83

GENERAL CHARACTERISTICS

MECHANICAL

Mounting (See Outline Drawing) - - - - - Support from Mounting Flange
Mounting Position - - - - - - Axis Vertical
Cooling - - - - - - Water & Forced Air
Connections:
- Filament - - - - - - - Flexible Leads
- Cathode - - - - - - Cylindrical Strap
- Focus Electrode - - - - - Cylindrical Strap
- Cavities - - - - Multiple Contact Fingers
- Collector - - - - - - Cylindrical Strap

Klystron Type	"A"	"F"	"K"	
Maximum Overall Dimensions:				
Length	54	49	45	inches
Diameter	5 1/8	5 1/8	5 1/8	inches
Net Weight	53	48	46	pounds
Shipping Weight	185	175	170	pounds

ELECTRICAL

Filament: Pure Tungsten
- Voltage - - - - - - - - 9.0 volts
- Current (with cathode cold) - - - 42 amperes
- Current (with cathode at operating temperature) - - - 39 amperes
- Maximum Allowable Short Circuit Current of Filament Current Source - - 84 amperes

Cathode: Unipotential; heated by electron bombardment

MAXIMUM CATHODE RATINGS
- DC VOLTAGE - - - - 2300 MAX. VOLTS
- DC CURRENT - - - - .75 MAX. AMPERES
- DC POWER - - - - 1600 MAX. WATTS

Focus Electrode
- *Voltage (with respect to cathode) - 0 to —500 volts

Magnetic Field: Axial (See Magnetic Circuit Schematic)
- Field Strength (approximately) - - - - 120 gauss

*May be varied over a range of 0 to —500 volts if beam current control is desired.

ULTRA HIGH FREQUENCY POWER AMPLIFIER

MAXIMUM RATINGS

DC BEAM VOLTAGE	19.5 MAX.	KILOVOLTS
DC BEAM CURRENT	2.56 MAX.	AMPERES
COLLECTOR DISSIPATION	50.0 MAX.	KILOWATTS

Note: Maximum beam voltage and beam current should not be applied without r-f excitation.

TYPICAL OPERATION

RF Linear Amplifier—Television Visual Service (In accordance with United States Federal Communications Commission Standards)

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage (approximately)	2100	volts
DC Cathode Bombarding Current (approximately)	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	17.2	kilovolts
DC Beam Current	2.15	amperes
DC Collector Current (approximately)[1]	1.72	amperes
Peak Synchronizing Level (80% of saturation power)		
Driving Power (approximately)[2]	55	watts
Power Output	12.0	kilowatts
Efficiency	41	percent
Black Level		
Collector Dissipation (approximately)[1]	30	kilowatts
Driving Power (approximately)[2]	33	watts
Power Output	7.2	kilowatts
Efficiency	19	percent

RF Amplifier—Television Aural Service

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage	2100	volts
DC Cathode Bombarding Current	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	12.3	kilovolts
DC Beam Current	1.33	amperes
DC Collector Current[1]	1.06	amperes
Driving Power[3]	20	watts
Collector Dissipation (approximately)[1]	10	kilowatts
Power Output	6	kilowatts
Efficiency	36	percent

[1]Minor tube-to-tube variations may be expected.

[2]Total driving power includes losses inserted for broadband operation. The output power is useful power measured in a load circuit.

[3]The driving power is the total power required by the tube and a resonant circuit.

APPLICATION

Mounting—The klystrons are provided with a mounting flange (See Outline Drawing) which may be used to support the tubes with either end up.

Filament Operation—For maximum tube life, the pure tungsten filament should be operated just above the emission limiting temperature. This temperature will be obtained with a filament voltage, as measured directly at the terminals, of approximately 9 volts.

Cathode Heating Power—The cathode is unipotential and heated by electron bombardment. A dc potential of approximately 2100 volts is applied between the filament and the cathode; and the recommended cathode heating power of 1400 watts is obtained with approximately .66 amperes. The filament is designed to operate under space-charge limited conditions. Cathode temperature is varied by changing the bombarding potential between the filament and the cathode.

Cooling—Forced air is used to cool the Electron Gun Structure and the Middle and Output Cavities. Only clean, well filtered air should be blown on the tube to avoid voltage breakdown due to dust accumulation. The temperature of the metal in the region of the metal-to-glass seals should not exceed 150°C. Tube temperatures may be measured with a temperature-sensitive paint, such as "Tempilaq", manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y.

Water is used to cool the Drift Tubes and the Collector Assembly. The cooling water should be of sufficient purity to prevent liming of the water system, and the use of a heat exchanger is recommended. The inlet water pressure of the Drift Tubes and the Collector Assembly should not exceed 50 pounds per square inch. The outlet water temperature must not exceed a maximum of 70°C. under any condition.

Air and water flow should be started before the filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

Klystron Cooling Requirements for Typical Operating Conditions and Correct Magnetic Field Adjustment:

	Cooling Medium	Volume	Pressure Drop	Remarks
Input Drift Tube	*Water	1 gpm	1 psi	Total pressure drop if series connected with 5/16" tubing = 4 psi.
Short Drift Tube Jacket	*Water	1 gpm	1 psi	
Long Drift Tube Jacket	*Water	1 gpm	1 psi	
Output Drift Tube	*Water	1 gpm	1 psi	
Collector Assembly	*Water	15 gpm	3 psi	

		Cooling Medium	Volume	Remarks
Electron Gun Structure	Filament Stem	Air	1-2 cfm	See Cooling Diagram
	Cathode Terminal	Air	90 cfm	
	Focus Electrode and Anode Seals	Air	90 cfm	
Input Cavity		None		
Center Cavity		Air	15 cfm	
Output Cavity		Air	50 cfm	

*Cooling water connections should be made as noted on Cooling Diagram.

RF Contact Surfaces—The means by which contact is made between the cavities and the tuning boxes is of great importance. Two requirements which must be met to ensure proper electrical connections are as follows:

(1) Contact to the tube cavities must be made only on the peripheral surface of the 1/4" cavity flanges as shown on the outline drawing.

(2) Each individual finger of the collet or spring stock material must make positive contact to the cavity flange to prevent arcing.

Magnetic Field—An adjustable magnetic field is necessary to control and direct the beam throughout the length of the drift tube. The magnetic field should be capable of variation around the recommended field strength of 120 gauss. Typical magnetic circuit requirements for a 3K50,000LK are shown in the Magnetic Circuit Schematic. The current and adjustment of the pre-focusing coil are optimized under low beam voltage conditions and will require minor readjustment with changes in beam voltage. The current and location of the focusing coils should be capable of independent adjustment. Readjustment of the current of the focusing coils is necessary with changes in beam voltage. Beam transmission (collector current divided by the beam current as measured in the cathode return to beam power supply) will vary from 75% to 95%. Improper adjustment or misalignment of the magnetic field, as indicated by too low a value of beam transmission, may cause the beam to strike and overheat the drift tube walls.

MAGNETIC FIELD COIL REQUIREMENTS

Number of Coils Required for Field Strength of Approximately 120 Gauss.

Tube Type	Pre-focusing Coil: 375-750 ampere-turns per coil	Focusing Coils: 1600-4800 ampere-turns per coil	Focusing Coils: 0-1600 ampere-turns per coil
3K50,000LA	1	3	1
3K50,000LF	1	3	1
3K50,000LK	1	2	1

CAUTION—It is convenient to operate the r-f and collector portions of the tube at ground potential. Since the cathode and filament are operated at high negative potentials with respect to ground, filament and cathode power supplies and voltmeters must be adequately insulated for these high voltages. Protection must also be afforded to operating personnel.

Protection—It is recommended that the following protective devices be used:

(1) Interlocks in air and water supplies.

(2) Interlocks in magnetic field supply circuits.

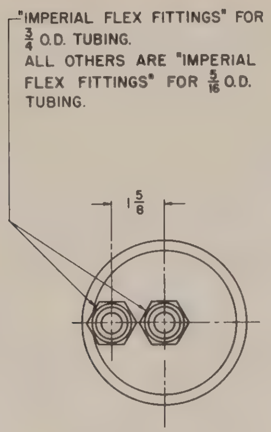
(3) Current overload in cathode bombardment supply circuit.

(4) Current overload in beam current supply circuit.

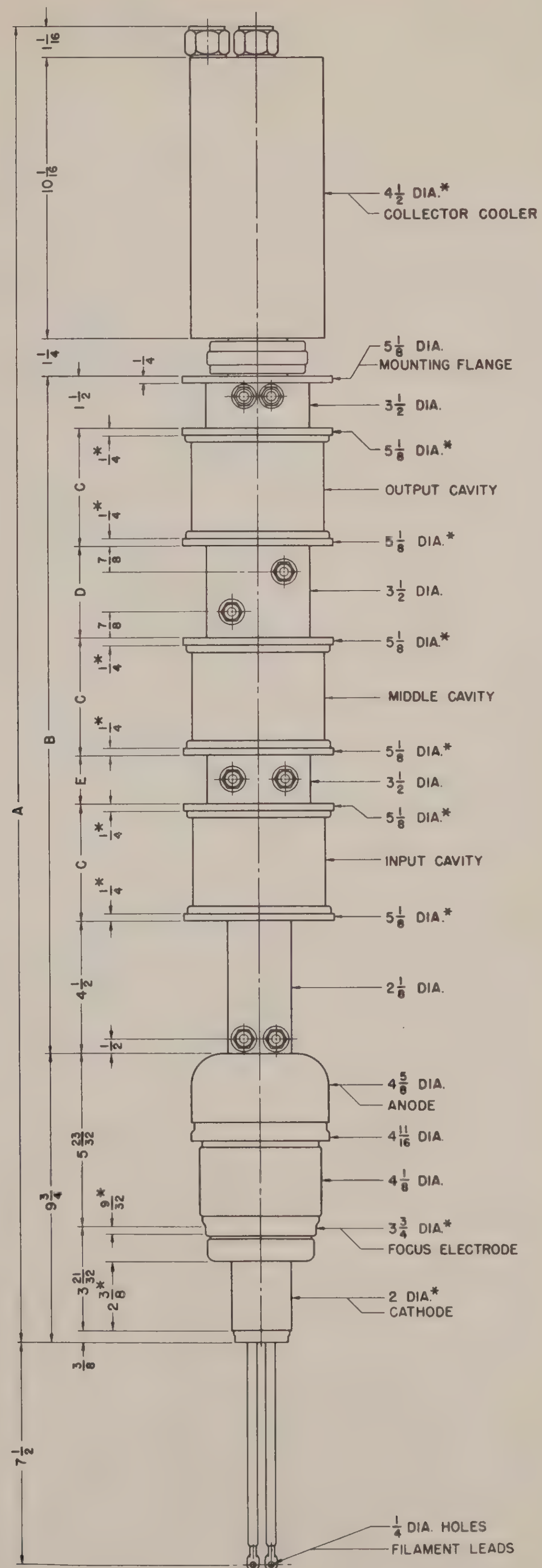
(5) Current overload in cavity current circuit.

(6) Current limiting resistor of approximately 100 ohms in series with beam power supply to isolate tube from final capacitor of supply.

The filament and cathode bombardment voltages will normally be applied before the beam voltage. Cavity tuning or magnetic field adjustment should be made with reduced beam voltage (1/2 to 2/3 normal). Slight retuning and readjustment will be necessary when beam voltage is raised to full value.



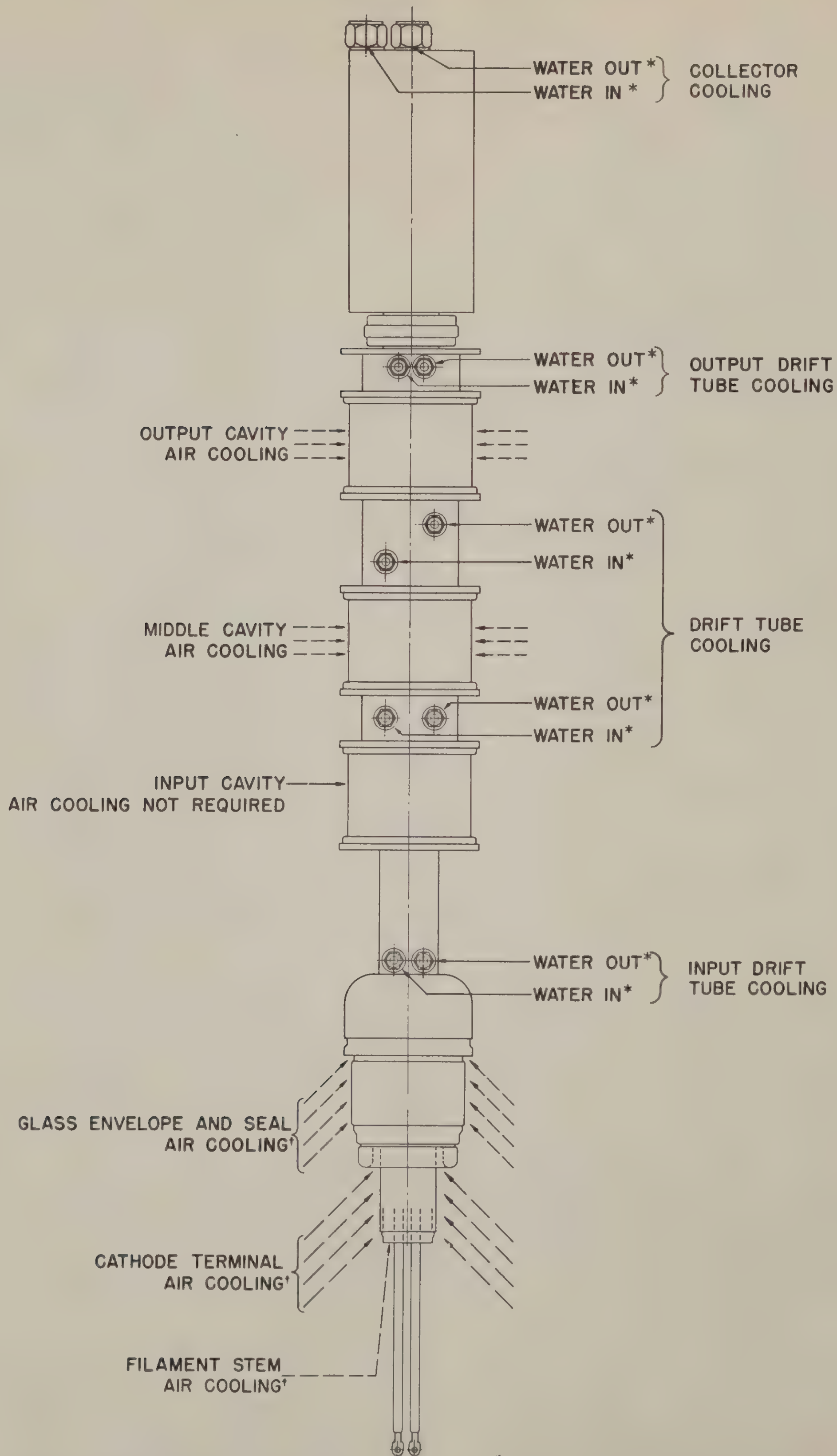
OUTPUT END VIEW



	A	B	C	D	E
3K50,000 LA	53 3/8	31 1/4	6	4 7/8	2 3/8
3K50,000 LF	48 7/8	26 3/4	5	3 3/4	2
3K50,000 LK	44 7/8	22 3/4	4	3 1/8	1 5/8

DIMENSIONS IN INCHES

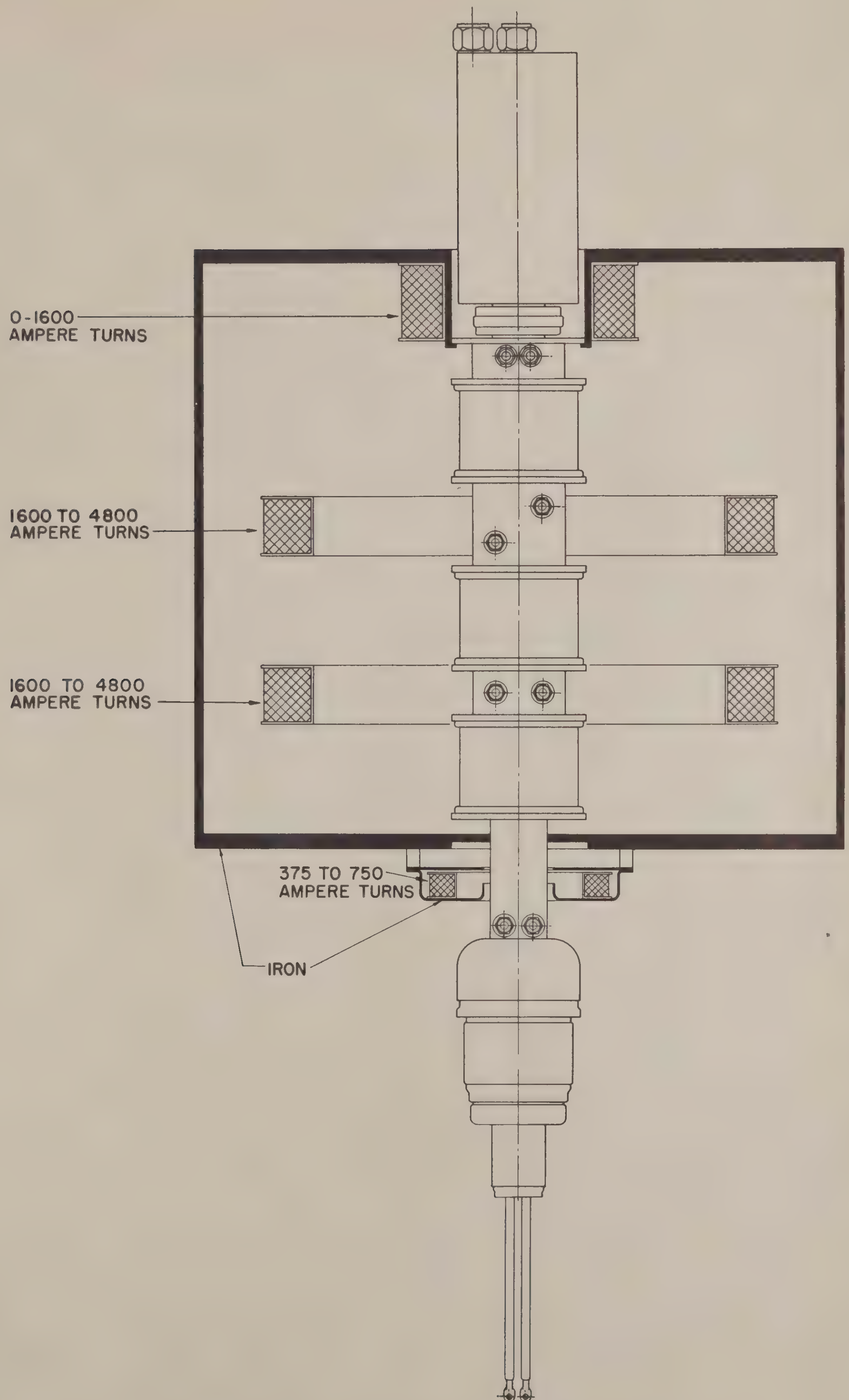
*CONTACT SURFACE



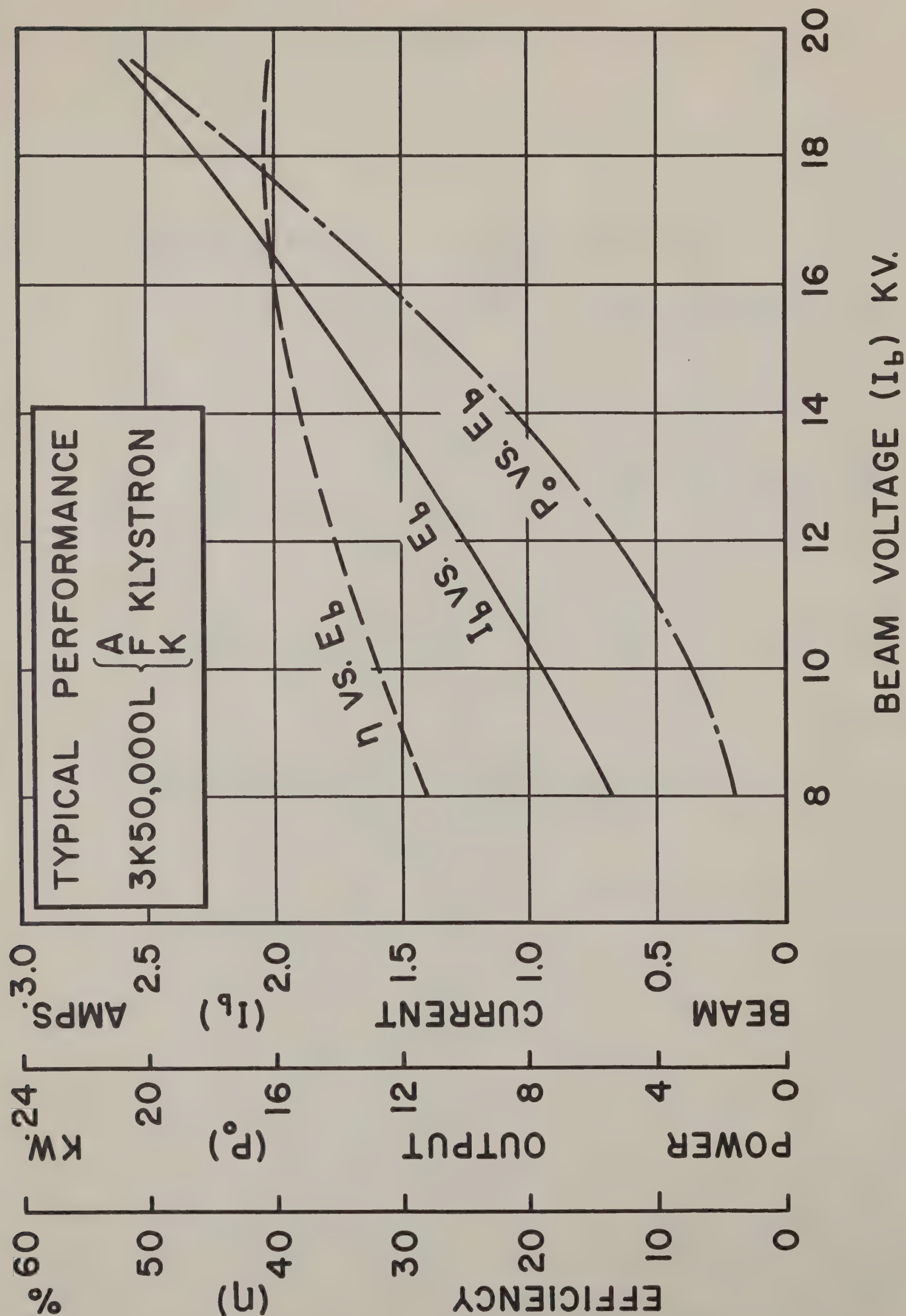
† THIS COOLING MAY BE SUPPLIED BY A SINGLE BLOWER THROUGH SUITABLE MANIFOLD & BAFFLES

* WATER CONNECTIONS ARE MADE AS SHOWN WHEN TUBE IS MOUNTED WITH COLLECTOR UP. WHEN TUBE IS MOUNTED WITH ANODE UP THE WATER CONNECTIONS MUST BE REVERSED.

COOLING DIAGRAM



MAGNETIC CIRCUIT SCHEMATIC FOR 3K50,000LK



BEAM CURRENT, POWER OUTPUT AND EFFICIENCY VS. BEAM VOLTAGE

2-G3-71962

TENTATIVE DATA

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

3K20,000LA
3K20,000LF
3K20,000LK

KLYSTRONS

L-BAND AMPLIFIERS

The Eimac 3K20,000LA, 3K20,000LF and 3K20,000LK klystrons are three cavity, magnetically focused power amplifiers intended primarily for UHF television broadcast service. Each klystron type, operating as a television visual r-f amplifier, will deliver 5.5 kW of peak synchronizing power output with a power gain of approximately 20 db. The cavities of the Eimac UHF television klystrons have ceramic windows and are completed by tuning boxes external to the tubes.

NOMINAL TUNING RANGE

The UHF television band (470-890 Mc) is covered by the three tube types as follows:

TUBE TYPE NUMBER	MC.	CHANNEL
3K20,000LA	470-580	14-32
3K20,000LF	580-720	33-55
3K20,000LK	720-890	56-83

GENERAL CHARACTERISTICS

MECHANICAL

Mounting (See Outline Drawing) - - - - - Support from Mounting Flange

Mounting Position - - - - - - Axis Vertical

Cooling - - - - - - - Water & Forced Air

Connections:
- Filament - - - - - - - Flexible Leads
- Cathode - - - - - - Cylindrical Strap
- Focus Electrode - - - - - Cylindrical Strap
- Cavities - - - - Multiple Contact Fingers
- Collector - - - - - - Cylindrical Strap

Klystron Type	"A"	"F"	"K"	
Maximum Overall Dimensions:				
Length	50	45	41	inches
Diameter	5 1/8	5 1/8	5 1/8	inches
Net Weight	42	37	35	pounds
Shipping Weight	160	150	145	pounds

ELECTRICAL

Filament: Pure Tungsten
- Voltage - - - - - - - 9.0 volts
- Current (with cathode cold) - - - 42 amperes
- Current (with cathode at operating temperature) - - - 39 amperes
- Maximum Allowable Short Circuit Current of Filament Current Source - - 84 amperes

Cathode: Unipotential; heated by electron bombardment

MAXIMUM CATHODE RATINGS
- DC VOLTAGE - - - - 2300 MAX. VOLTS
- DC CURRENT - - - - .75 MAX. AMPERES
- DC POWER - - - - 1600 MAX. WATTS

Focus Electrode
- *Voltage (with respect to cathode) - 0 to —500 volts

Magnetic Field: Axial (See Magnetic Circuit Schematic)
- Field Strength (approximately) - - - - 120 gauss

*May be varied over a range of 0 to —500 volts if beam current control is desired.

ULTRA HIGH FREQUENCY POWER AMPLIFIER

MAXIMUM RATINGS

DC BEAM VOLTAGE	14.0 MAX. KILOVOLTS
DC BEAM CURRENT	1.7 MAX. AMPERES
COLLECTOR DISSIPATION	20.0 MAX. KILOWATTS

Note: Maximum beam voltage and beam current should not be applied without r-f excitation.

TYPICAL OPERATION

RF Linear Amplifier—Television Visual Service (In accordance with United States Federal Communications Commission Standards)

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage (approximately)	2100	volts
DC Cathode Bombarding Current (approximately)	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	13	kilovolts
DC Beam Current	1.4	amperes
DC Collector Current (approximately)[1]	1.2	amperes
Peak Synchronizing Level (80% of saturation power)		
Driving Power (approximately)[2]	55	watts
Power Output	5.5	kilowatts
Efficiency	30	percent
Black Level		
Collector Dissipation (approximately)[1]	12.5	kilowatts
Driving Power (approximately)[2]	33	watts
Power Output	3.3	kilowatts
Efficiency	18	percent

RF Amplifier—Television Aural Service

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage	2100	volts
DC Cathode Bombarding Current	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	10.0	kilovolts
DC Beam Current	.95	amperes
DC Collector Current[1]	.8	amperes
Driving Power[3]	20	watts
Collector Dissipation (approximately)[1]	5.8	kilowatts
Power Output	2.75	kilowatts
Efficiency	29	percent

[1]Minor tube-to-tube variations may be expected.

[2]Total driving power includes losses inserted for broadband operation. The output power is useful power measured in a load circuit.

[3]The driving power is the total power required by the tube and a resonant circuit.

Supersedes 3K20,000LK Data Sheet with Effective Date of 3-10-53.

APPLICATION

Mounting—The klystrons are provided with a mounting flange (See Outline Drawing) which may be used to support the tubes with either end up.

Filament Operation—For maximum tube life, the pure tungsten filament should be operated just above the emission limiting temperature. This temperature will be obtained with a filament voltage, as measured directly at the terminals, of approximately 9 volts.

Cathode Heating Power—The cathode is unipotential and heated by electron bombardment. A dc potential of approximately 2100 volts is applied between the filament and the cathode; and the recommended cathode heating power of 1400 watts is obtained with approximately .66 amperes. The filament is designed to operate under space-charge limited conditions. Cathode temperature is varied by changing the bombarding potential between the filament and the cathode.

Cooling—Forced air is used to cool the Electron Gun Structure and the Middle and Output Cavities. Only clean, well filtered air should be blown on the tube to avoid voltage breakdown due to dust accumulation. The temperature of the metal in the region of the metal-to-glass seals should not exceed 150°C. Tube temperatures may be measured with a temperature-sensitive paint, such as "Tempilaq", manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y.

Water is used to cool the Drift Tubes and the Collector Assembly. The cooling water should be of sufficient purity to prevent liming of the water system, and the use of a heat exchanger is recommended. The inlet water pressure of the Drift Tubes and the Collector Assembly should not exceed 40 pounds per square inch. The outlet water temperature must not exceed a maximum of 70°C. under any condition.

Air and water flow should be started before the filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

Klystron Cooling Requirements for Typical Operating Conditions and Correct Magnetic Field Adjustment:

	Cooling Medium	Volume	Pressure Drop	Remarks
Input Drift Tube	*Water	1 gpm	1 psi	Total pressure drop if series connected with 5/16" tubing= 4 psi.
Short Drift Tube Jacket	*Water	1 gpm	1 psi	
Long Drift Tube Jacket	*Water	1 gpm	1 psi	
Output Drift Tube	Water	1 gpm	1 psi	
Collector Assembly	*Water	6 gpm	3 psi	

		Medium	Volume	Remarks
Electron Gun Structure	Filament Stem	Air	1-2 cfm	See Cooling Diagram
	Cathode Terminal	Air	90 cfm	
	Focus Electrode and Anode Seals	Air	90 cfm	
Input Cavity		None		
Center Cavity		Air	15 cfm	
Output Cavity		Air	50 cfm	

*Cooling water connections should be made as noted on Cooling Diagram.

RF Contact Surfaces—The means by which contact is made between the cavities and the tuning boxes is of great importance. Two requirements which must be met to ensure proper electrical connections are as follows:

(1) Contact to the tube cavities must be made only on the peripheral surface of the ¼" cavity flanges as shown on the outline drawing.

(2) Each individual finger of the collet or spring stock material must make positive contact to the cavity flange to prevent arcing.

Magnetic Field—An adjustable magnetic field is necessary to control and direct the beam throughout the length of the drift tube. The magnetic field should be capable of variation around the recommended field strength of 120 gauss. Typical magnetic circuit requirements for a 3K20,000LK are shown in the Magnetic Circuit Schematic. The current and adjustsment of the pre-focusing coil are optimized under low beam voltage conditions and will require minor readjustment with changes in beam voltage. The current and location of the focusing coils should be capable of independent adjustment. Readjustment of the current of the focusing coils is necessary with changes in beam voltage. Beam transmission (collector current divided by the beam current as measured in the cathode return to beam power supply) will vary from 75% to 95%. Improper adjustment or misalignment of the magnetic field, as indicated by too low a value of beam transmission, may cause the beam to strike and overheat the drift tube walls.

MAGNETIC FIELD COIL REQUIREMENTS

Number of Coils Required for Field Strength of Approximately 120 Gauss.

Tube Type	Pre-focusing Coil 375-750 ampere-turns per coil	Focusing Coils 1600-4800 ampere-turns per coil	Focusing Coils 0-1600 ampere-turns per coil
3K20,000LA	1	3	1
3K20,000LF	1	3	1
3K20,000LK	1	2	1

CAUTION—It is convenient to operate the r-f and collector portions of the tube at ground potential. Since the cathode and filament are operated at high negative potentials with respect to ground, filament and cathode power supplies and voltmeters must be adequately insulated for these high voltages. Protection must also be afforded to operating personnel.

Protection—It is recommended that the following protective devices be used:

(1) Interlocks in air and water supplies.

(2) Interlocks in magnetic field supply circuits.

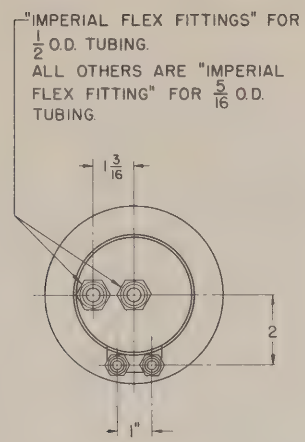
(3) Current overload in cathode bombardment supply circuit.

(4) Current overload in beam current supply circuit.

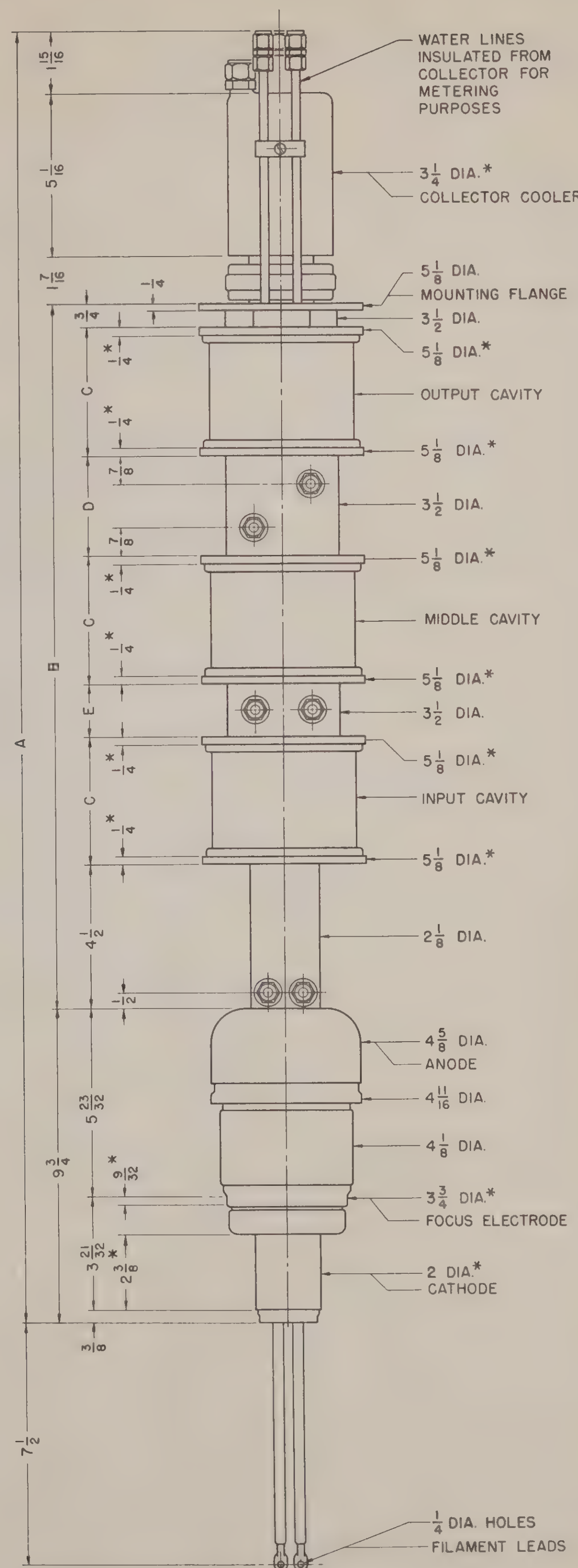
(5) Current overload in cavity current circuit.

(6) Current limiting resistor of approximately 100 ohms in series with beam power supply to isolate tube from final capacitor of supply.

The filament and cathode bombardment voltages will normally be applied before the beam voltage. Cavity tuning or magnetic field adjustment should be made with reduced beam voltage (1/2 to 2/3 normal). Slight retuning and readjustment will be necessary when beam voltage is raised to full value.



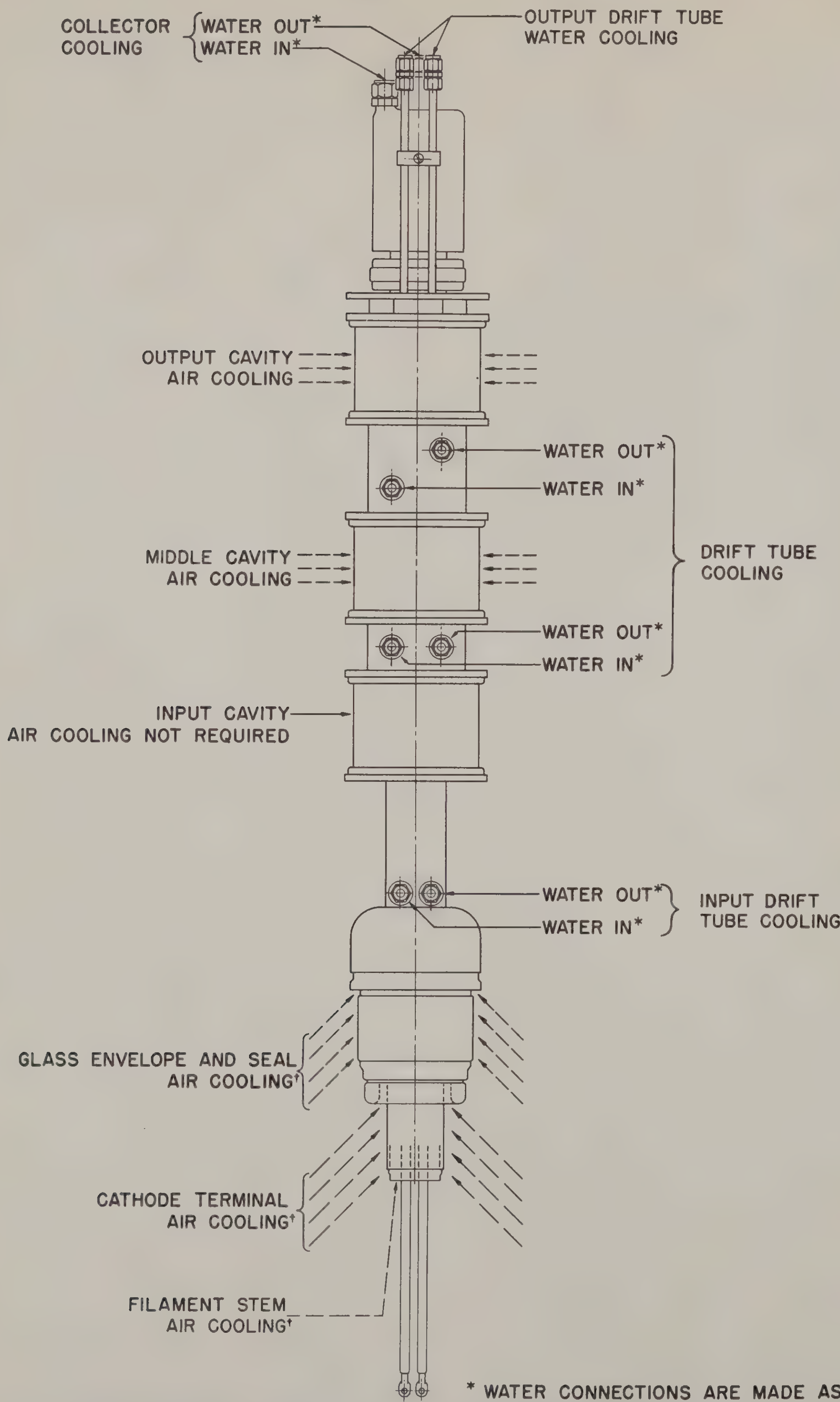
OUTPUT END VIEW



		A	B	C	D	E
3K20,000	LA	48 11/16	30 1/2	6	4 7/8	2 3/8
	LF	44 3/16	26	5	3 3/4	2
	LK	40 3/16	22	4	3 1/8	1 5/8

DIMENSIONS IN INCHES

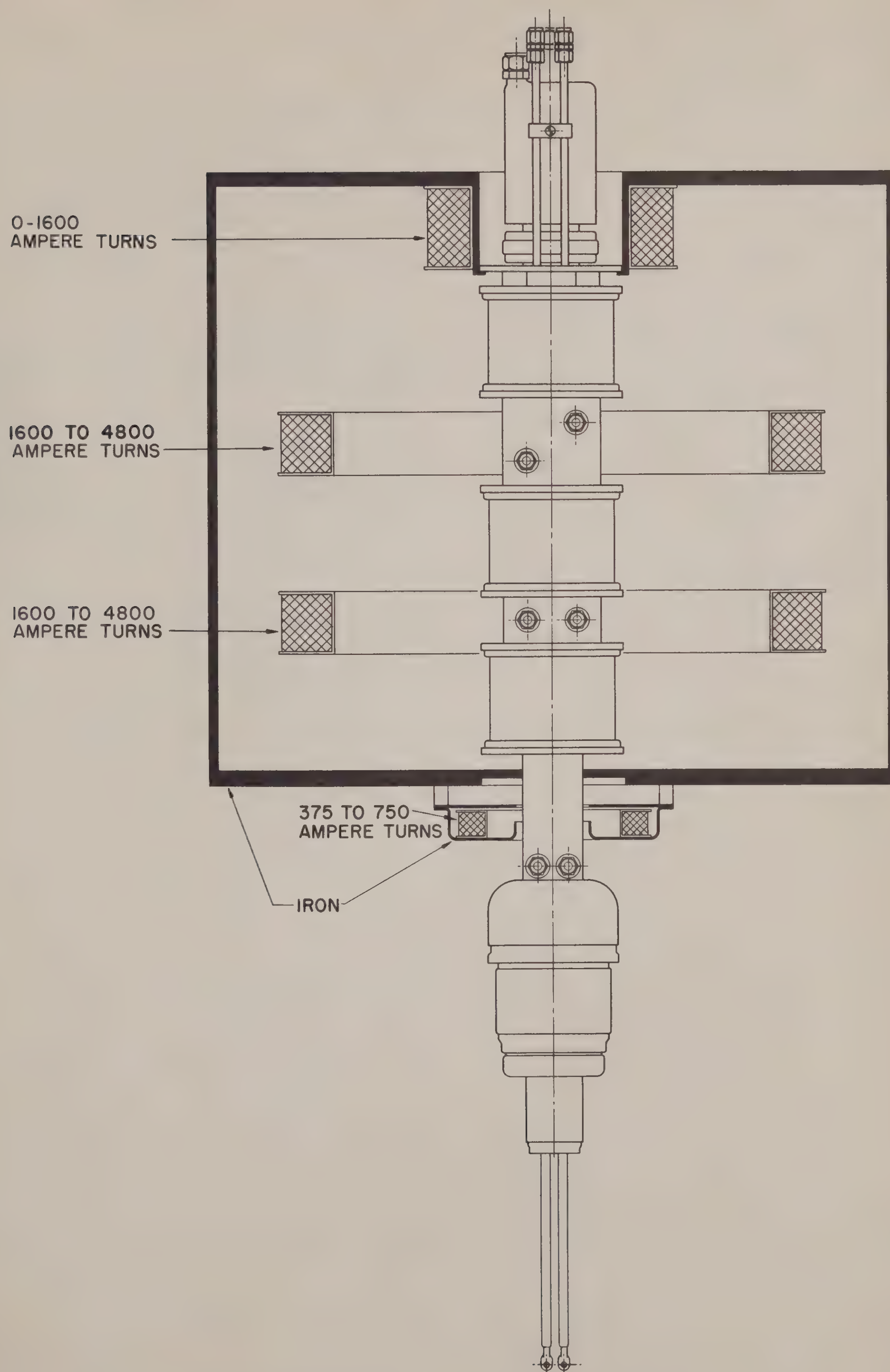
*CONTACT SURFACE



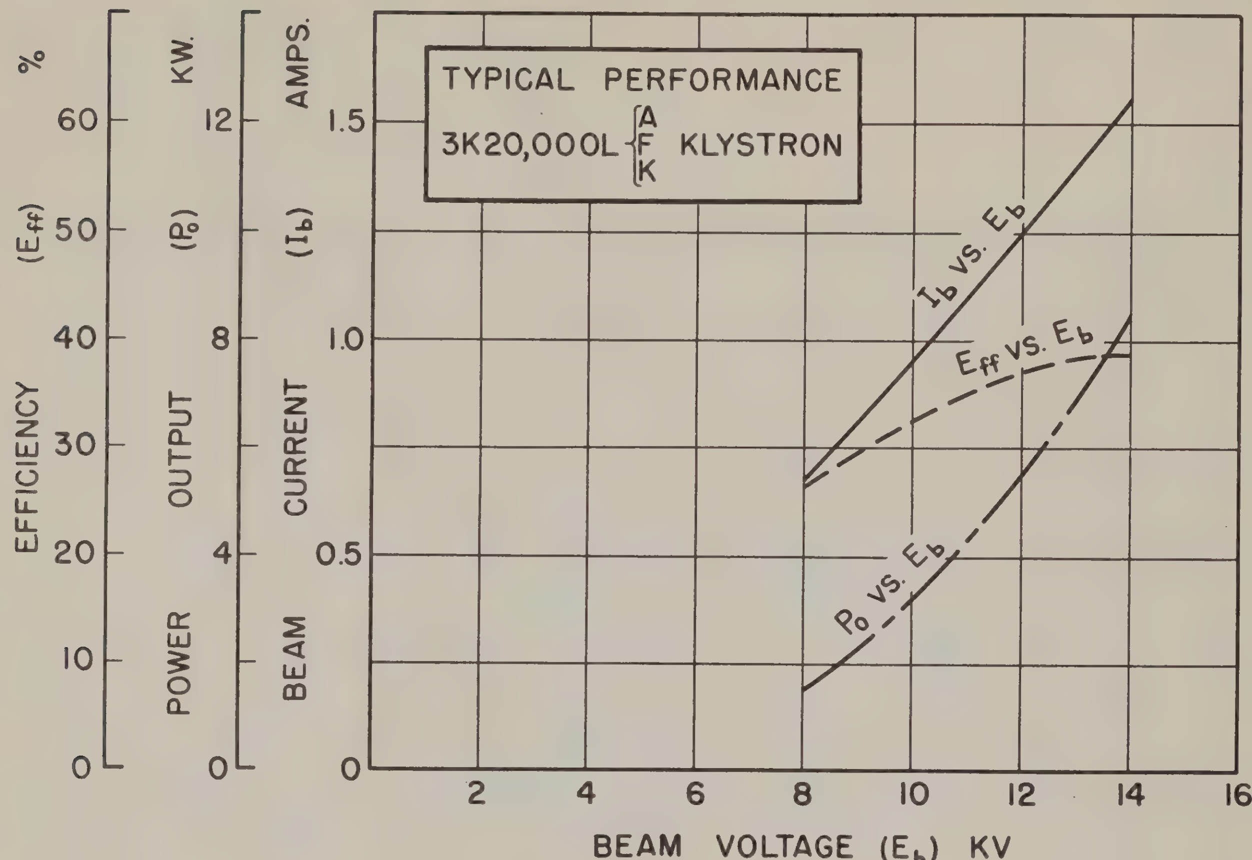
† THIS COOLING MAY BE SUPPLIED BY A SINGLE BLOWER THROUGH SUITABLE MANIFOLD & BAFFLES

* WATER CONNECTIONS ARE MADE AS SHOWN WHEN TUBE IS MOUNTED WITH COLLECTOR UP. WHEN TUBE IS MOUNTED WITH ANODE UP THE WATER CONNECTIONS MUST BE REVERSED.

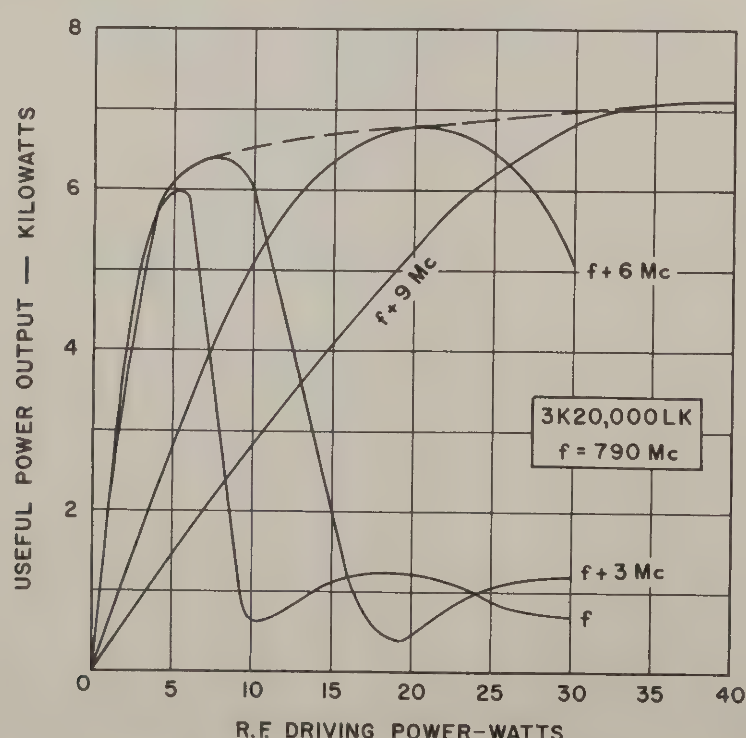
COOLING DIAGRAM



MAGNETIC CIRCUIT SCHEMATIC FOR 3K20,000LK



BEAM CURRENT, POWER OUTPUT AND EFFICIENCY VERSUS BEAM VOLTAGE



USEFUL POWER OUTPUT VS. R.F. DRIVING POWER
(MIDDLE CAVITY DETUNED; INPUT & OUTPUT CAVITIES TUNED TO DRIVE FREQUENCY)

2-G3-71963

High-Power Klystrons at UHF*

D. H. PREIST†, MEMBER, IRE, C. E. MURDOCK†, ASSOCIATE, IRE, AND J. J. WOERNER†

Summary—A brief history of high-power cw klystron development and a classification of types of klystron are followed by a description of the three-cavity, gridless klystron amplifier with magnetic focusing, in general terms, and the Eimac 5-kw klystron for UHF-TV in more detail. This tube has cavities which are partly outside the vacuum system and contain ceramic "windows." The advantages of the klystron over the conventional negative-grid type of tube are reviewed from the standpoint of performance, and the main operational features are noted.

Introduction

IN VIEW OF the increasing activity above 450 mc for such purposes as television, it may be of value to review the means of generating transmitter power presently available.

Of outstanding interest in this field is the post-World War II development of power amplifier klystrons. Although the klystron principle was discovered as far back as 1939,[1] its application to high-power generation was delayed, largely because of the 1939–1945 war and the need to concentrate on those lines of development which appeared the most promising for military purposes. The ultimate possibilities of the klystron were appreciated by few, and although a great deal of fundamental research on electron beams was carried on in various places, development in the field of high-power cw tubes was confined mainly to one group in California,[2,3] and one group in France.[4,5] As a result of this work the basic principles have been extended, and much progress has been made in techniques of construction, culminating in the recent appearance of high-power klystrons for commercial purposes in the United States,[2,6] and an increasing awareness of the great advantages of this type of tube for stable amplification at high-power levels.

The object of this paper is to review, briefly, from the point of view of the potential user, the performance of a modern high-power klystron, and to describe the special peculiarities and methods of operation of this type of tube. A brief survey will also be made of the factors limiting the performance of a klystron, compared with the factors limiting the performance of conventional negative-grid tubes.

* Decimal classification: R339.2×R583.6. Original manuscript received by the Institute, November 3, 1952.
† Eitel-McCullough, Inc., San Bruno, Calif.

[1] R. H. Varian and S. F. Varian, "A high frequency oscillator and amplifier," *Jour. Appl. Phys.*, vol. 10, p. 321; 1939.
[2] "High Power UHF Klystron," *Tele-Tech*, p. 60; October, 1952.
[3] W. C. Abraham, F. L. Salisbury, S. F. Varian, and M. Chodorow, "Transmitting Tube Suitable for UHF TV," paper presented at IRE National Convention; 1951.
[4] P. Guénard, B. Epsztein, and P. Cahour, "Klystron Amplificateur de 5 KW à large bande passante," *Ann. Radioelect.*, vol. VI, p. 24; 1951.
[5] R. Warnecke and P. Guénard, "Tubes à Modulation de Vitesse," Gauthier-Villards, Paris; 1951.
[6] J. J. Woerner, "A High Power UHF Klystron for TV Service," paper presented at IRE National Convention; 1952.

Klystron Types

Present-day klystrons fall into three categories:

1. *Reflex Klystron Oscillators*
Most of these have low efficiency (of the order of 1 per cent) and generate relatively low power, and are suitable for receivers, local oscillators, test equipment, and the like.
2. *2-Cavity Klystrons*
These may be used as amplifiers, oscillators, or frequency multipliers; as amplifiers they are capable of power gains of about 13 db and efficiencies of about 20 per cent, at frequencies of the order of 1,000 mc.
3. *3-Cavity Klystrons*
These are useful, principally, as amplifiers, and are capable of power gains of about 20 to 30 db, and efficiencies of 30 to 40 per cent, together with bandwidths of several mc, at frequencies of the order of 1,000 mc. Because of the superior amplifier performance given by this type of klystron, the other two types will not be dealt with further in this paper.

3-Cavity Gridless Klystron Amplifier with Magnetic Focussing

A. Description

This type of tube, sometimes called a "cascade amplifier," is illustrated schematically in Fig. 1. It will be seen to consist of four essential parts:

1. *The Electron Gun*
This has a source of electrons (the cathode), a means of accelerating the electrons to a high energy level (the anode), and a means of focussing the electrons into a parallel beam of high electron density emerging from the hole in the anode.

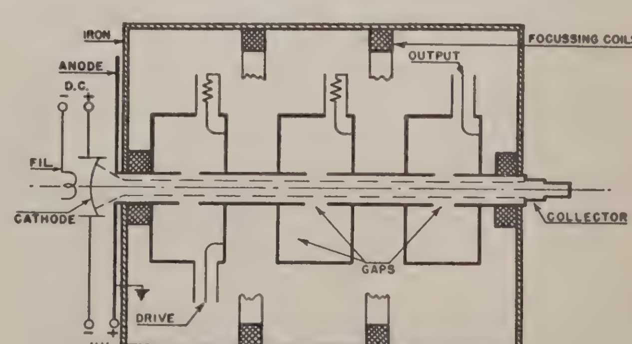


Fig. 1—Schematic diagram of 3-cavity klystron with magnetic focusing.

2. *The RF Resonant Cavities and Drift Tubes*
The first cavity is fed with RF energy from a driving source at low level. The second cavity is tuned to resonance, or near resonance, but is not fed with energy from outside. The function of these two cavities, in conjunction with the drift tubes, is to velocity-modulate the electron beam so as to produce "bunches" of electrons at the output cavity. The latter is tuned to resonance and coupled to the antenna, or other load, and serves to extract as much RF energy as possible from the "bunched" electron beam. Its function and operation are closely similar to those of the output circuit of a Class "C" amplifier using triodes or tetrodes.
3. *The "Collector" Electrode*
This collects the electrons after they have passed through the output cavity, and have given up part of their energy to the RF field, and thus to the load; because only about 30 per cent of the energy in the beam is converted to RF energy, this collector has to be capable of dissipating the remaining percentage, that is to say, 70 per cent of the product of the anode-cathode voltage and cathode current, when fully driven. (In practice the collector current is very slightly less than this because some electrons inevitably strike the anode and the drift-tube walls.) If the tube is used as a linear modulated amplifier, the collector will be required to dissipate 100 per cent of the input power under conditions of zero drive and zero output.
4. *External Magnetic Circuit*
This consists of suitably disposed electromagnets producing an axial magnetic field of controllable strength which tends to keep the beam parallel as it passes along the tube. Without this field the beam would expand because of the mutual repulsion of the electrons. The optimum field strength is fairly critical, and is not necessarily uniform along the length of the tube. It is usually prevented from penetrating the cathode, either by a metallic magnetic shield or by the use of a "bucking" coil, or by a combination of both.

B. *Performance and Operational Features of This Type of Klystron*

The 3-cavity klystron is a tube capable of generating a much larger power output at uhf than the conventional negative-grid tube. The deterioration of performance as the frequency is raised is slight. The power gain of the klystron is very much larger than that of a tetrode. It may be worthwhile to review briefly the reasons for this.

Considering the factors limiting the power output of a triode or tetrode, aside from external circuit losses, one finds that basically they are the total cathode emission, the anode voltage, the interelectrode spacing, and the RF loss in the materials used to make the electrodes and the envelope. Now the total cathode emission, assuming the best material is used and that a given life is required, depends on its area. This area is limited at uhf because the tube forms part of a resonant transmission line in which large changes of electric and magnetic field occur over distances which are small compared with the wavelength. Since nonuniform potentials between electrodes cause loss of efficiency, it is necessary to keep the electrode dimensions small compared with the wavelength; thus, the cathode area is limited, and has to be reduced as the wavelength is decreased. The anode voltage is limited by internal flash-arcs between electrodes. The electrode spacing must, however, be small enough to give small electron transit times, and must be decreased with the wavelength. The applied voltage must, therefore, be reduced also with the wavelength. Lastly, the RF losses in the tube materials increase as the wavelength decreases. All these factors added together give the well-known result that triodes and tetrodes get rapidly smaller as the wavelength decreases, and so does the power they will generate and the efficiency. In addition, the problem of manufacture becomes more and more serious, and ultimately becomes prohibitive. The two worst problems are caused by the small spacing between electrodes, of the order of 0.001 inch, and the mechanical weakness of the fine wire grids.

Considering now the power gain, this becomes less as the wavelength decreases because the tube requires more and more driving power to overcome the increasing electron transit-time effects, losses in materials, grid current, and (usually) inherent negative feedback.

In a klystron, on the other hand, some of these limitations do not occur at all, and others are less significant. The cathode area is not limited by the wavelength because it is outside the RF field. The anode-to-cathode spacing being of the order of 1 inch, extremely high anode voltages may be applied without internal flash-arcs; also, the cavity gap spacings may be about $\frac{1}{2}$ inch in a 5-kw tube at 1,000 mc. Again, because gridless gaps may be used without serious loss of coupling between the beam and the resonant cavities, there are no problems of fabrication or heating of grid wires. Furthermore, because the collector is outside the RF field, it may be designed solely for the purpose of dissipating heat, and this becomes a minor problem in practice. The losses in the conductive tube materials are small because all the metal parts carrying RF current may be made of high-conductivity metal. (There is no loss comparable to the RF losses in a triode due to RF current flowing through lossy cathode material or fine resistive grid wires.) Therefore, the only limiting factor approached in klystrons giving adequate power for present commercial applications is the loss in the dielectrics. Some dielectrics are inevitable either in the form of windows in the cavities, as in the Eimac tube, or in the other type of tube with integral cavities, the window between the

output cavity and the load. If the power level is raised high enough, these dielectrics will ultimately break down, either by cracking due to heat or by flashing over the outside surface which is at atmospheric pressure; however, this does not occur in a well-designed tube at power levels that are presently interesting.

Considering the power gain of a klystron, this is governed almost entirely by the geometry and is limited only by the small RF losses in the input cavity and the beam loading of the cavity, which is small. The transit-time loading experienced with a triode becomes a factor of minor importance, and the negative feedback disappears since there is no coupling between the input and output cavities.

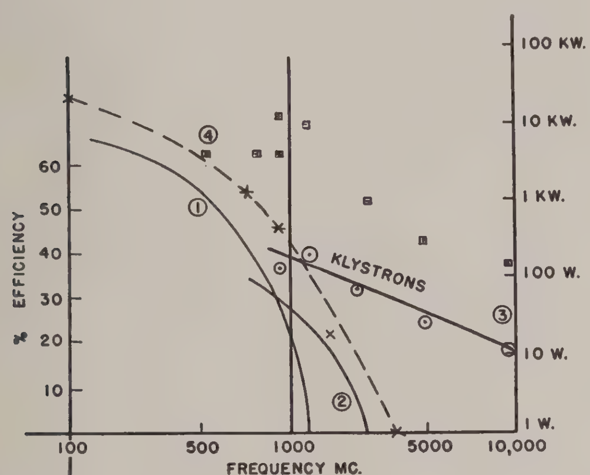


Fig. 2—Curve (1): Efficiency versus frequency for typical uhf tetrode —4X150G. (Plate dissipation 150 watts.)
Curve (2): Efficiency versus frequency for typical uhf triode —2C39. (Plate dissipation 100 watts.)
Curve (3): Typical efficiency of klystrons versus frequency (independent of output power). This is the efficiency at the optimum frequency for each tube.
Curve (4) (dotted): Maximum power output of the largest commercially available negative-grid tube at various frequencies.
Points ⊡ cw power output of various klystrons (not the largest possible).

It is, therefore, apparent that the efficiency and power gain of a klystron will fall off relatively slowly, compared with a triode or tetrode, as the wavelength is reduced. This is illustrated by the curves in Fig. 2. It is also clear that the maximum size and power output of a klystron are not determined by the wavelength. It follows that the klystron is ideally suited to high-power generation at uhf and microwave frequencies, and outclasses the conventional type of tube in every respect, including ease of manufacture.

Turning now to a typical performance obtainable from a 3-cavity klystron, the results given by the Eimac tube may be taken as representative of this type of tube. This tube will generate 5 kw of RF power in the uhf television band with an efficiency of more than 30 per cent when fully driven. The over-all bandwidth is about 5 mc and the power gain, under television conditions, is about 20 db. Salient features of operation are these:

The tuning of each of the 3 cavities is independent of the others since there is no feedback present. This makes for very simple lining-up procedure.

The output cavity is tuned to resonance at the mid-band frequency, and loaded for optimum performance by means of some variable coupling device external to the tube.

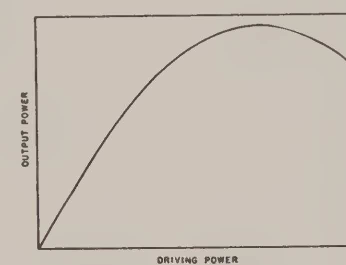


Fig. 3—Output power versus driving power for klystron.

A curve of power output against power input for this type of tube is a Bessel function of the first order and the first kind, and the first part of such a curve is very nearly linear. (See Fig. 3.) In television service, assuming that sync stretching is used in the driving stages, the klystron may be operated in such a way that the sync pulses drive the tube very nearly to the peak of the Bessel curve, so that the efficiency at sync pulse levels is nearly the fully driven efficiency.

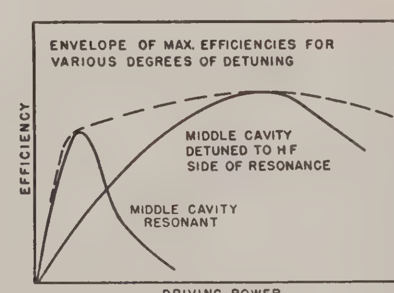


Fig. 4—Efficiency versus driving power, showing the effect of detuning the middle cavity.

The center cavity is detuned to a frequency slightly higher than the midband frequency, since this gives greater efficiency than resonant operation, and helps to broaden the pass band. This cavity may be loaded externally by resistance in some cases. This detuned operation requires greater driving power to the first cavity than resonant operation. (See Fig. 4.)

The input cavity may be either detuned on the low-frequency side of resonance or it may be tuned to resonance and loaded with external resistance in order to achieve the necessary bandwidth.

The relation between efficiency, power output, and anode voltage for a given tube is shown at Fig. 5. There is an optimum voltage for best efficiency because the voltage determines the speed of the electrons along the tube. Now a certain time is required for electron bunching to take place; this depends mainly on the frequency and determines the distance between the cavities. But this distance will be optimum for only one electron speed, and therefore only one voltage. Conversely, for a given voltage the relation between efficiency and frequency will also show a broad peak at a given frequency, and this fall-off at higher and lower frequencies will limit the useful frequency range of a given tube, even if the cavities are tunable over an indefinitely wide range.

The power input from the dc power supply feeding the anode of the tube is constant (about 1.5 amps at 13 kv), and independent of the drive voltage; therefore, the regulation of this power supply may be quite poor without adverse effects. Also, only simple circuits are necessary to reduce the hum to a low level. The filament may be heated by ac.

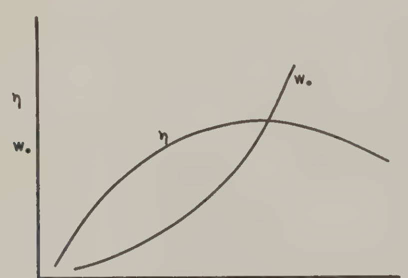


Fig. 5—Power output and efficiency versus anode voltage.

The magnetic field used for focussing the beam is simple to arrange, and relatively low in intensity, and consumes only a small amount of dc power in the coils. It must be made variable since the efficiency of the tube varies fairly rapidly with the field strength and reaches a maximum for an optimum setting of the magnetic field. The RF cavities, the drift tubes, and the anode are all in metallic contact and may be grounded. Thus, there is no problem of by-passing and dc isolation in the output circuit compared to the by-passing problem with a triode or tetrode amplifier. The collector is usually insulated from the main part of the tube in order to facilitate monitoring of the current division between the collector and the drift tubes. The anode voltage supply is grounded on the positive side, and the negative side is connected to the cathode of the tube.

Considering now the over-all problem of design, construction, installation, and operation of a high-power uhf amplifier, and the difference between the problem with a conventional type of tube and with a klystron, it is evident that the klystron scores heavily in all respects. The burden imposed on the transmitter designer is lessened because the klystron with its cavities forms a complete amplifier stage in itself. Because of the absence of feedback in the klystron, the circuit design is greatly simplified, compared with the conventional amplifier design. Also, when using a conventional tube at uhf, the designer is usually faced with the very difficult problem of obtaining the maximum efficiency from a stage in which the tube is run to its limit, and only by very careful design can the desired performance be obtained from it. With klystrons, on the other hand, the problem is easier because there is usually a greater margin of performance, both in respect to output and power gain. Also, the construction of a klystron stage is simpler than the conventional stage, and, as we have seen, the operation is also simpler.

Fig. 1 shows the more or less conventional type of klystron construction involving integral cavities, namely, cavities which are an integral part of the vacuum system. A unique feature of the Eimac tube, hereinafter described, is that part of the cavities are external to the tube envelope so that simple mechanical tuning of the cavities over a wider band of frequencies is possible. The tube itself is also simplified.

C. A Practical Example: Eimac UHF Klystron for TV

The photograph in Fig. 6 shows the Eimac uhf klystron, an example of a 3-cavity klystron in a form suitable for commercial manufacture, and now in produc-

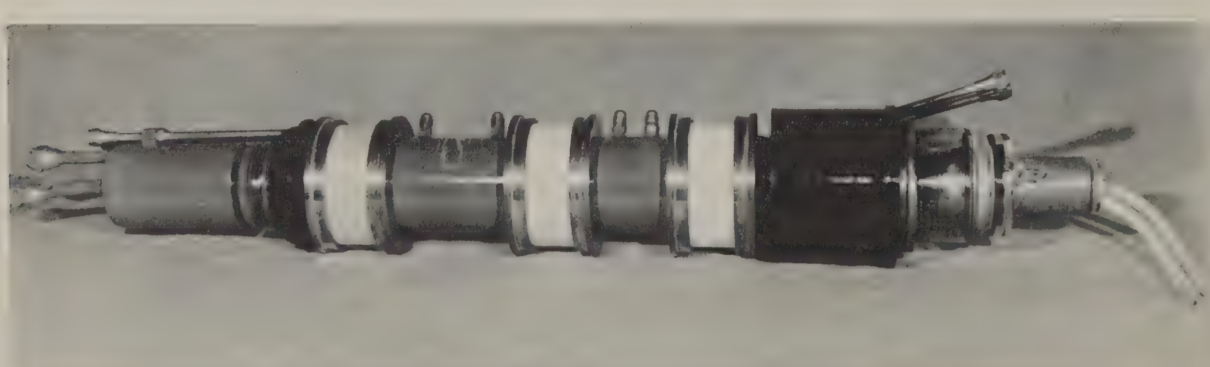


Fig. 6—The Eimac 5-kw uhf klystron for TV.

tion. Tube-cavity parts and drift-tube sections are shown in Fig. 7. Fig. 8 shows the tube and external cavities in a test setup.

Fig. 7—Tube cavity parts and drift tube sections.

Fig. 8—The 5-kw klystron on test.

A feature of interest is the use of cavities which are tunable by means external to the vacuum system. This is made possible by use of ceramic "windows" which, if designed and fabricated correctly, will produce only a minor deterioration in the over-all performance of the tube because of their finite dielectric loss and high dielectric constant.

This means that part of each cavity is in vacuo and part is in air. The convenience of operating a tube of this type, compared with a tube in which the cavities are entirely in vacuo, is considerable. In the first place, the mechanism for varying the resonant frequency is simple and may involve straightforward shorting bars with sliding contacts with negligible losses. These slidable devices are outside the vacuum system, as shown in Fig. 8. The tuning range of such a cavity is large. With a totally evacuated cavity it has not yet been found possible to use such a means of tuning, because sliding contacts in vacuo are generally unsatisfactory. Therefore, tuning has to be done by distortion of some flexible metallic membrane. Such a membrane introduces mechanical weaknesses into the tube structure which then has to be stiffened by an external frame. Also, the range of tuning is relatively small, and usually the tuning is done by varying the gap spacing, and therefore, its capacitance. This can be done only to a limited extent. If the gap is made too wide, the electron transit time will become an appreciable fraction of 1 RF cycle, causing inefficiency; on the other hand, if the gap is too small, the bandwidth will suffer (bandwidth varies roughly as 1/c). With a ceramic window cavity the tuning is done by varying the inductance of the cavity, the capacitance across the gap is fixed, and the gap can be set for optimum performance over the frequency band.

Another point of difference is that the mechanical forces required to tune a cavity by means external to the vacuum system are small, being determined only by friction, whereas with the other type of cavity the tuning mechanism has to withstand the forces caused by the operation of atmospheric pressure against the flexible metallic membrane.

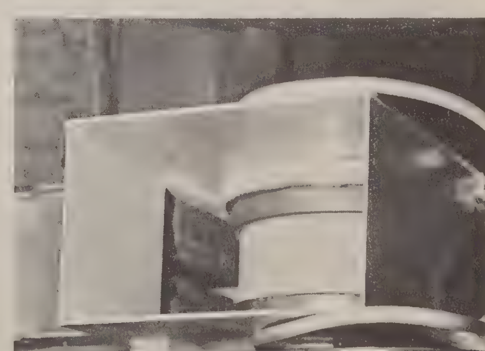


Fig. 9—Output cavity with one tuning plunger removed, showing ceramic and output coupling device.

Another desirable feature obtained with the ceramic windows is that the loading of the cavity may be accomplished outside the vacuum system, either by loops or a waveguide-to-cavity loading device, such as a quarter-wave transformer made from ridge waveguide. (See photograph of output cavity, Fig. 9.) The coupling may, therefore, be varied with ease. With a totally evacuated cavity it is very inconvenient to build in a variable load coupling, and it is common practice to use

a fixed loop; thus the benefit of variable coupling is lost.

Lastly, because of the relatively large frequency band that can be covered by a given klystron with ceramic windows, a smaller number of tube designs is required to cover a given frequency band, such as the uhf TV band. This simplifies the manufacturing problem and reduces the cost of the tube.

Another feature of interest is the use of a tantalum cathode heated by electron bombardment from a tungsten filament of relatively small size by means of a dc power supply (0.6 amps. at 2,000 volts) between the cathode and the filament. This constitutes a flexible system, and is much simpler to design and construct than a radiation-heated cathode.

Conclusions

The 3-cavity externally tunable klystron is excellently suited to high-power generation at uhf (and also at higher frequencies) because

1. it is relatively simple to manufacture,
2. it is easy to use and adjust,
3. the transmitter design and construction is simplified by its use,
4. its performance as an amplifier is greatly superior to other tube types.

It is likely that the future will see more and more such tubes in commercial service for an increasing variety of applications.

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VOL. 41, NO. 1, JANUARY, 1953

NOTE

The appended reprint from the PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS describes early experimental klystron structures.

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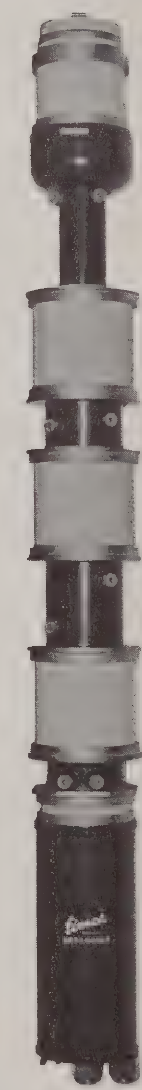
3K50,000LQ

POWER-AMPLIFIER L-BAND KLYSTRONS

The Eimac 3K50,000LA, 3K50,000LF and 3K50,000LQ are ceramic and metal three-cavity, magnetically focused, power-amplifier klystrons. Although intended primarily for UHF television broadcast service, these klystrons cover the frequency range of 365 to 985 megacycles when used with appropriate Eimac Klystron Amplifier Circuit Assemblies. Circuit assemblies include the necessary magnetic frame and coils, external tuning boxes, adjustable load coupler, and SK-110 Air-System Socket.

Each klystron type, when tuned for narrow-band CW operation, will deliver a minimum output power of 10 kilowatts with a power gain of 25 db. In television visual service, each klystron type will provide more than 12 kilowatts of peak synchronizing output power with a power gain of 20 db.

Resonant cavities for these UHF klystrons are completed through the cylindrical ceramics of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows repeated tuning cycling without damage to vacuum seals.



3K50,000LF KLYSTRON

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Pure Tungsten		
Voltage	8.0	volts
Current	40	amperes
Maximum Starting Current	80	amperes
Cathode: Unipotential, Bombardment Heated		
Voltage	2100	volts
Current	0.66	ampere
Power	1400	watts
Power Gain: Narrow-Band CW or FM	25	db
Television Visual Service	20	db
Output Power:		
Narrow-Band CW or FM	10,000	watts
Television Visual (Peak Synchronizing Level)	12,000	watts

Frequency Range Using Standard Eimac Circuit Assemblies*

Klystron Type	Circuit Assembly	Frequency Range	
3K50,000LA	H-108	400 to 600	mc
3K50,000LF	H-109A	570 to 660	mc
3K50,000LF	....	650 to 720	mc
3K50,000LQ	H-111	720 to 985	mc

*Eimac circuit assemblies for these klystrons covering other frequency ranges between the limits of 365 and 985 megacycles may be obtained on special order.

MECHANICAL

Operating Position	Axis vertical*			
Cooling (See "Application")	Water and forced air			
R-F Input Coupling	Type "N" coaxial fitting			
R-F Output Coupling	Standard $3\frac{1}{8}$-inch 50-ohm air line			
Maximum Over-All Dimensions: Klystron Type	"A"	"F"	"Q"	
Length	$51\frac{1}{4}$	$49\frac{3}{4}$	$39\frac{7}{8}$	inches
Diameter	$5\frac{1}{8}$	$5\frac{1}{8}$	$5\frac{1}{8}$	inches
Net Weight	53	51	48	pounds
Shipping Weight (Approximate)	150	140	130	pounds

*Cathode end up when installed in standard Eimac circuit assemblies.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20 MAX. KILOVOLTS
D-C BEAM CURRENT	2.5 MAX. AMPERES
D-C BODY CURRENT (CONTINUOUS)	150 MAX. MA
D-C BODY CURRENT (TUNING ONLY)	250 MAX. MA
FOCUS-ELECTRODE VOLTAGE	—500 MAX. VOLTS
BOMBARDED CATHODE:	
D-C VOLTAGE	2400 MAX. VOLTS
D-C CURRENT	750 MAX. MA
D-C POWER	1600 MAX. WATTS
COLLECTOR DISSIPATION	50 MAX. KILOWATTS

Supersedes sheet dated 8-17-53.

TYPICAL OPERATION

R-F LINEAR AMPLIFIER Television Visual Service
(In accordance with United States Federal Communications Commission Standards)

Frequency	640	megacycles
Peak Synchronizing Level (80% of Saturation Power)		
Output Power	12	kilowatts
Driving Power	55	watts
Power Gain	23	db
Efficiency	32.4	percent
Black Level		
Output Power	7.2	kilowatts
Driving Power	33	watts
Power Gain	23	db
Efficiency	19.5	percent
D-C Beam Voltage	17.2	kilovolts
D-C Beam Current	2.15	amperes
D-C Body Current	100	milliamperes
D-C Collector Current	2.05	amperes
D-C Focus-Electrode Voltage	0	volts
Bombarded Cathode:		
Voltage*	2100	volts
Current*	660	milliamperes
Power	1400	watts
Magnetic-Coil Currents:*		
Prefocus	0.8	ampere
First Body	1.7	amperes
Second Body	2.5	amperes
Collector	1	ampere

*Approximate values.

NOTE: Driving power includes the power required to overcome losses inserted for broad-band operation.

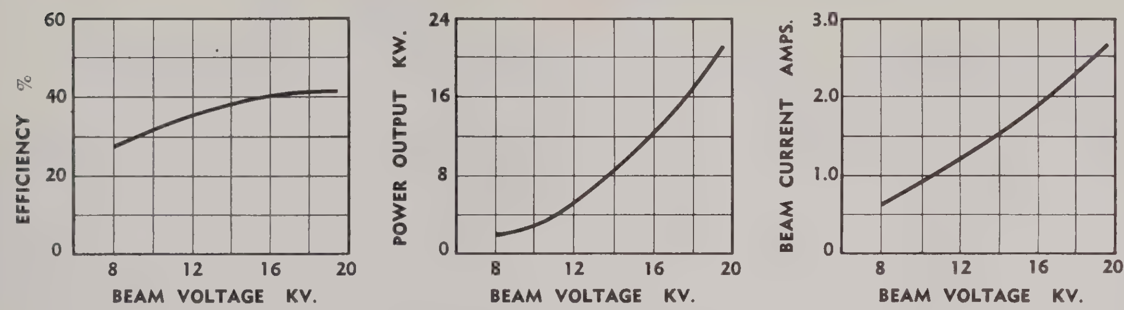
R-F AMPLIFIER Television Aural Service or Narrow-band CW

Frequency	640	megacycles
Output Power	10.7	kilowatts
Driving Power	17	watts
Power Gain	28	db
Efficiency	42.2	percent
D-C Beam Voltage	15	kilovolts
D-C Beam Current	1.65	amperes
D-C Body Current	90	milliamperes
D-C Collector Current	1.56	amperes
D-C Focus-Electrode Voltage	0	volts
Bombarded Cathode:		
Voltage*	2100	volts
Current*	660	milliamperes
Power	1400	watts
Magnetic-Coil Currents:*		
Prefocus	0.7	ampere
First Body	1.2	amperes
Second Body	1.7	amperes
Collector	0.8	ampere

*Approximate values.

NOTE: Driving power is the total power required by the tube and resonant circuit.

TYPICAL PERFORMANCE 3K50,000LA, F, Q KLYSTRON



EFFICIENCY, POWER OUTPUT AND BEAM CURRENT VS. BEAM VOLTAGE

APPLICATION

Mounting—Each klystron is provided with a mounting flange (see Outline Drawings) which may be used to support the tube with either end up.

Although satisfactory installations have been made with the collector end up, it is recommended that where feasible, the klystron be installed with the cathode end up. Standard Eimac Klystron Amplifier Circuit Assemblies are designed for this type of installation.

Filament Operation—The filament is designed to operate under space-charge-limited conditions. For maximum life, the pure tungsten filament should be operated just above the emission-limiting temperature. This temperature will be obtained with a filament voltage, as measured directly at the tube terminals, of approximately 8 volts.

Cathode Heating Power—The cathode is unipotential and heated by electron bombardment. With a d-c potential of approximately 2100 volts applied between the filament and cathode, the recommended cathode heating power of 1400 watts is obtained with approximately 0.66 ampere. For applications where relatively low beam voltages and currents are required, the cathode temperature may be decreased with a consequent increase in tube life. Cathode temperature is always varied by changing the bombarding potential between the filament and the cathode.

Cooling—Forced air is used to cool the electron-gun structure and the output cavity. Only clean, well-filtered air should be blown on the tube to avoid voltage breakdown due to dust accumulation.

The temperature of the metal in the region of the ceramic-to-metal seals should not exceed 150°C. Tube temperatures may be measured with the aid of a temperature-sensitive paint, such as "Tempilaq", obtainable from the Tempil Corporation, 132-34 West 22nd St., New York 11, N.Y. or from various chemical or scientific-equipment suppliers.

Water is used to cool the drift tubes and the collector assembly. The cooling water should be of sufficient purity to prevent the deposit of scale and consequent deterioration of cooling efficiency. The use of a closed system is recommended. The inlet water pressure at the drift tubes and collector assembly should not exceed 50 pounds per square inch and the outlet water temperature must not exceed a maximum of 70°C under any conditions.

Air and water flow should be started before filament and cathode power are applied. Simultaneous removal of power and cooling (as in the case of a power failure) will not ordinarily injure the tube, but it is not recommended as a standard operating practice. Following the removal of power, a nominal delay of two minutes is recommended before the removal of cooling.

Minimum cooling requirements for operation at maximum ratings and correct magnetic-field adjustment are tabulated below. For operation under conditions where collector dissipation is considerably less than the maximum rating, less water flow through the collector assembly may be justified provided that the outlet water temperature does not exceed 70°C. Water flow through the drift-tube jackets should not be less than the amounts specified under any conditions.

Water Cooling (Connections as noted on "Cooling Diagram")

	Volume	*Pressure Drop*
First Drift-Tube Jacket	1 gpm	1.6 psi
Second Drift-Tube Jacket	1 gpm	1.6 psi
Third Drift-Tube Jacket	1 gpm	1.6 psi
Fourth Drift-Tube Jacket	1 gpm	1.6 psi
Collector Assembly	25 gpm	28 psi

NOTE: All drift tubes may be series connected with 5/16-inch tubing with negligible additional pressure drop.

Air Cooling

	Volume	*Pressure Drop*
Electron-Gun Assembly (Using Eimac SK-110 Socket)	52 cfm	5 inches H_2O
Output Cavity	50 cfm	1.5 inches H_2O

Installation Precautions—While tuning the klystron and associated circuit assembly, it is very important that the operator have an unobstructed view of the body-current meter and the output-power meter while adjusting the position of the prefocus coil, cavity doors, and output coupling loop and the magnitude of coil

currents. If it is intended that the klystron circuit assembly be installed in a closed cabinet, the positioning adjustments may be accomplished through mechanical linkages or by means of remote-controlled motors.

To prevent distortion of the beam-controlling magnetic field it is important that no steel or iron objects be located near the circuit-assembly magnetic frame and that the assembly be isolated from strong fields. If the klystron circuit assembly is to be installed in a cabinet of ferrous material, it is important that it be symmetrically positioned within the enclosure and that cabinet sides are at least six and preferably twelve inches from the magnetic frame. Before starting the tuning procedure, all tools, nuts, bolts, etc. must be removed from the vicinity of the magnetic frame.

To protect the klystron ceramic window in the output cavity, it is important that the load presented to the output cavity be substantially "flat". A VSWR of 1.2 or less is satisfactory and means should be provided in the transmission line to allow continuous monitoring of this ratio.

Magnetic-Field Requirements—A magnetic frame, a prefocus coil, two body coils, and a collector coil are component parts of each of the three standard Eimac Klystron Amplifier Circuit Assemblies designed for use with these tubes. To establish and control the required magnetic field, a separate and smoothly-variable d-c power supply must be used to supply current to each of these coils. Each supply should be capable of five-percent voltage stability and have a ripple component of less than one percent.

The required voltage and current maximums for each magnetic coil of the circuit assembly designed for use with these three klystron types are tabulated below.

	LA	*LF*	*LQ*	
Prefocus-Coil Voltage	25	25	25	volts
Prefocus-Coil Current	1	1	1	ampere
Each of Two Body Coils:				
Voltage	265	175	175	volts
Current	3	3	3	amperes
Collector-Coil Voltage	100	50	50	volts
Collector-Coil Current	3	1.5	1.5	amperes

Note that a stronger field is required to control the beam of the 3K50,000LA. This is due to the greater inter-gap spacing and resultant greater total length inherent in the design of a klystron operable at the relatively low frequencies covered by this tube.

Power Supplies—Magnetic-coil power-supply requirements are outlined above. Other power supplies used in the installation of one of these klystrons are listed below with minimum stability and ripple requirements.

Power Supply	*Percent Stability*	*Percent Ripple*
Filament	5	......
Cathode Bombarder	5	4
Beam	5	0.1

The focus electrode in each of these klystron types is normally operated at zero potential with respect to the cathode. In cases where it is desired to operate with bias on the focus electrode, the supply should have a stability of one percent or better and a ripple component of less than 0.03 percent. It should also incorporate a bleeder drawing at least 10 milliamperes.

In installations where it is desired to obtain this bias from the bombarder supply, means must be provided to assure that the voltage applied to the focus electrode meets the minimum stability and ripple requirements outlined above.

CAUTION—Since it is convenient to operate the r-f and collector portions of the tube at ground potential, the cathode, filament, and focus electrode are normally at high negative potentials with respect to ground. Filament, cathode, and focus-electrode (when used) power supplies and voltmeters must be adequately insulated for these high voltages and protection must be provided for operating personnel.

Tuning Precautions—The following precautions must be observed in the tuning or operation of these klystrons.

(1) The output cavity must be overcoupled (maximum coupling is obtained with the output-coupling loop in a vertical position) at all times with one to five-percent less than maximum output power delivered to the load under normal operating conditions. Additional overcoupling, with a resultant ten-percent decrease in output power, is required before raising beam voltage or making any adjustment that may result in an increase of output power.

(2) The middle cavity must be tuned to the high-frequency side of resonance at all times. It must be further detuned to a higher frequency, with a resultant additional ten-percent decrease in output power, prior to raising beam voltage, retuning the input cavity, or increasing driving power.

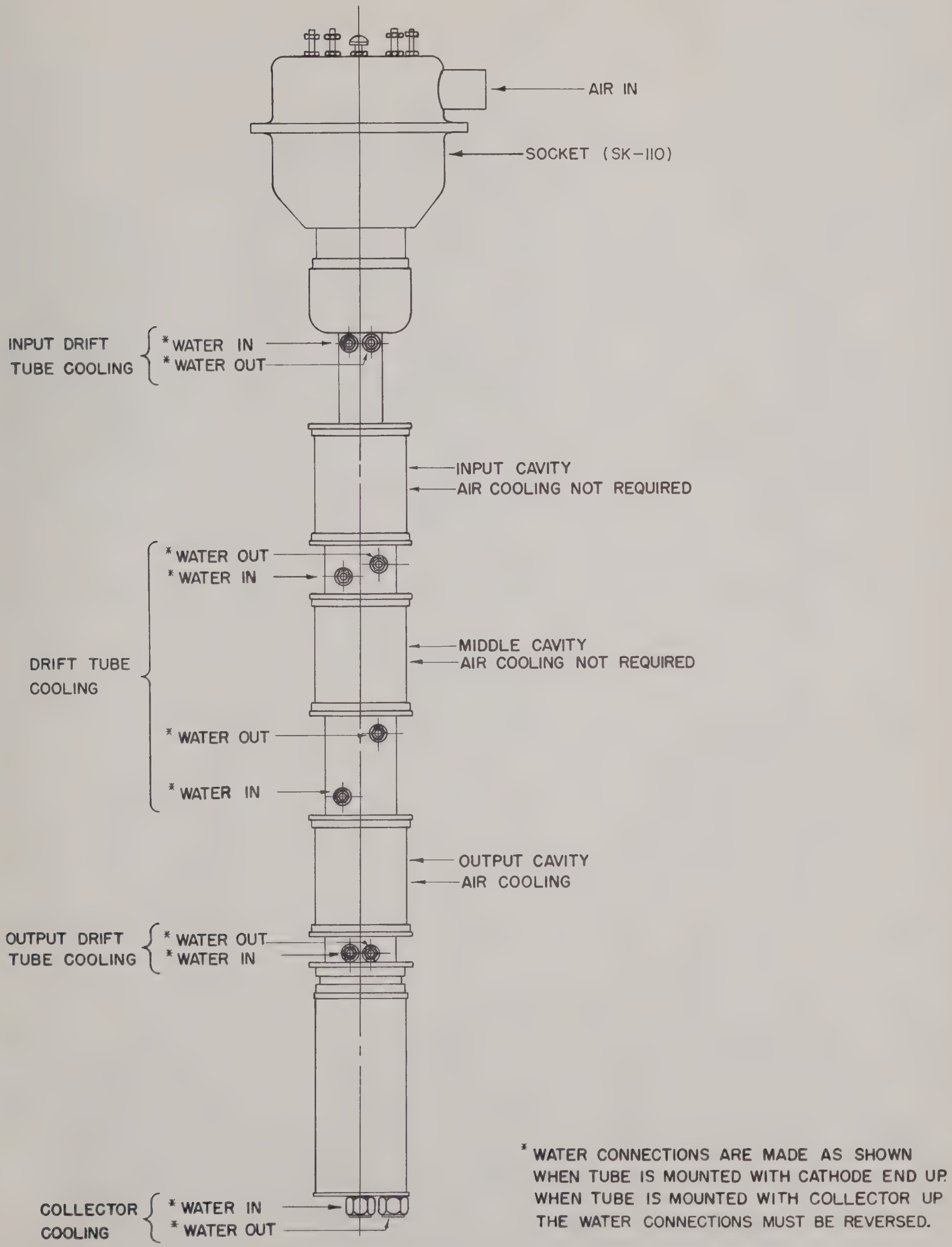
(3) The position of the prefocus coil should not be adjusted while operating at beam voltages higher than ten kilovolts.

For more detailed tuning instructions, write to the Application Engineering Department, Eitel-McCullough, Inc.

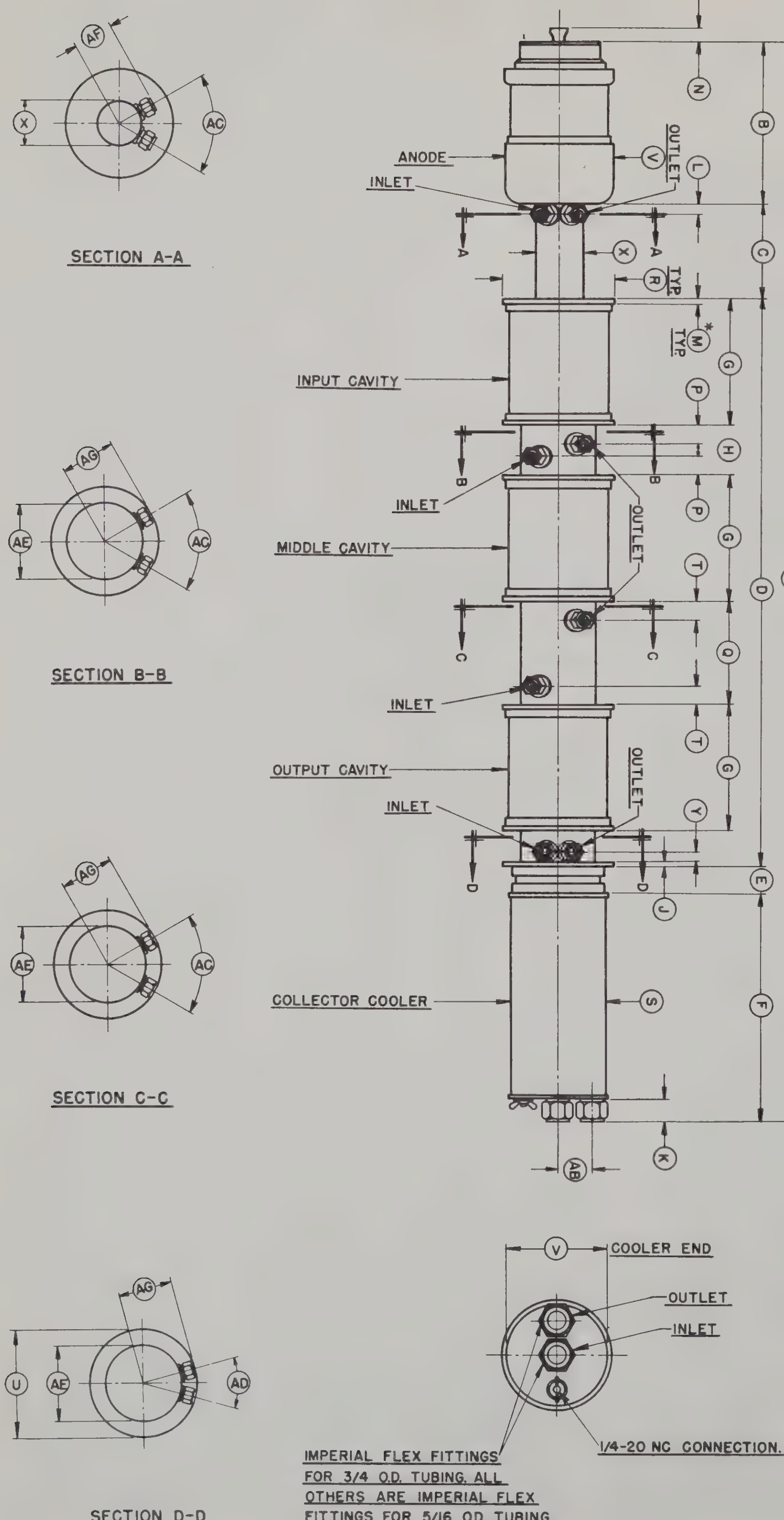
Protection—It is recommended that the following protective devices be installed in any system employing one of these klystrons.

(1) Interlocks in air and water supplies
(2) Interlocks in magnetic-field supply circuits.
(3) Current overload in cathode-bombardment supply circuit.
(4) Current overload in beam-current supply circuit.
(5) Current overload in body-current circuit.
(6) Current-limiting resistor of approximately 100 ohms in series with beam power supply to isolate tube from final capacitor of supply.
(7) Protective device in output coaxial line to turn off either driving power or beam voltage in the event of an increase in reflected power or VSWR.

Special Applications—If it is desired to operate one of these klystrons under unusual conditions or over frequency ranges other than those listed, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California for information and recommendations.

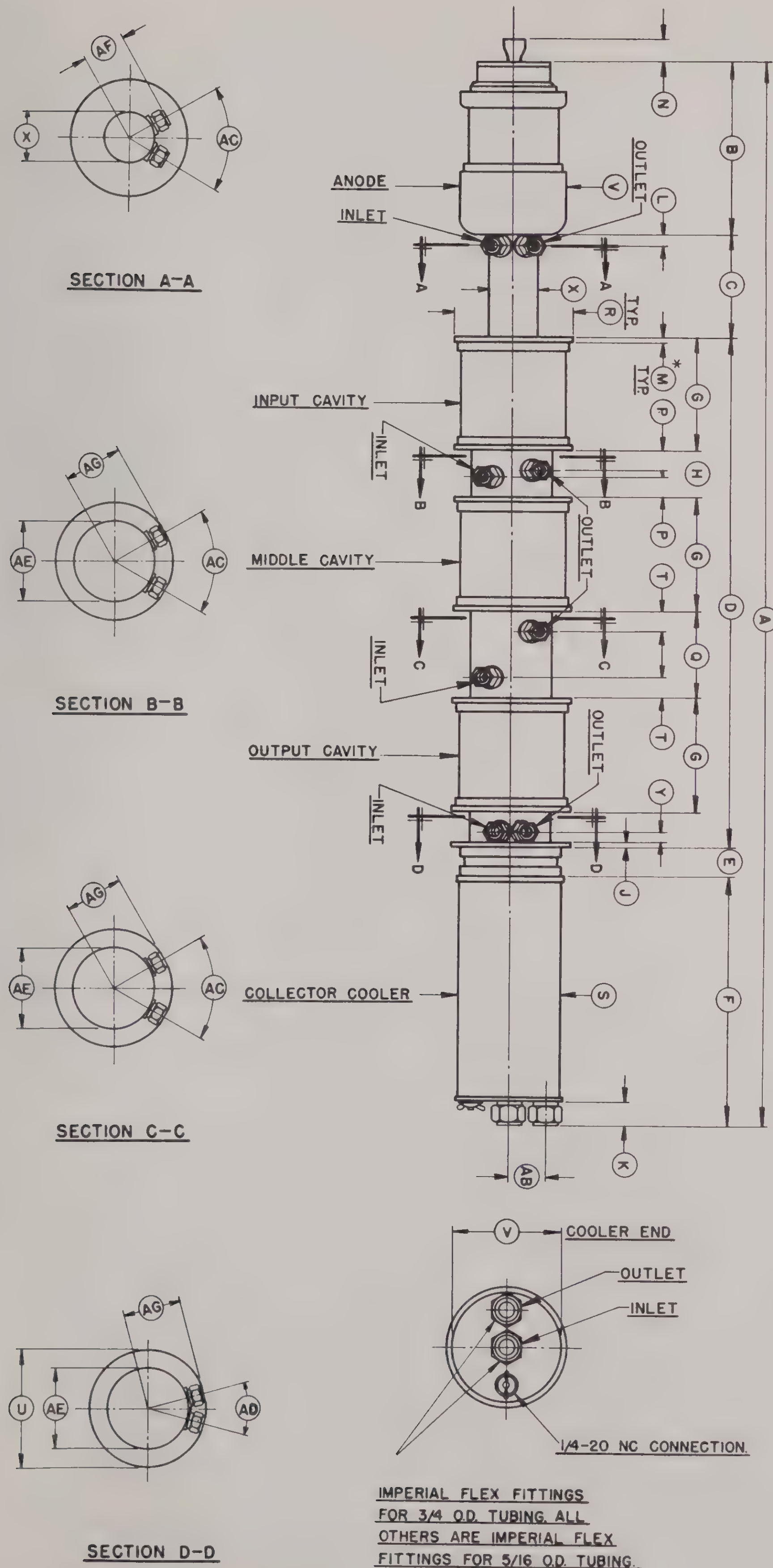


COOLING DIAGRAM



DIMENSION DATA			
REF.	NOM:	MIN.	MAX.
A		51.245	51.365
B		7.475	7.510
C		4.490	4.525
D		26.730	26.760
E		1.245	1.270
F		11.285	11.350
G		5.095	6.020
H		2.350	2.380
J		.235	.255
K		1.055	1.190
L		.495	.550
M		.187	
N	.750		
P		.870	.920
Q		4.855	4.880
R		5.118 DIA.	5.125 DIA.
S		4.490 DIA.	4.505 DIA.
T		.870	.920
U		5.118 DIA.	5.128 DIA.
V		4.620 DIA.	4.630 DIA.
X		2.120 DIA.	2.135 DIA.
Y		.430	.445
AB		1.560	1.630
AC	60°		
AD	30°		
AE		3.495 DIA.	3.510 DIA.
AF	1.875		
AG	2.5625		

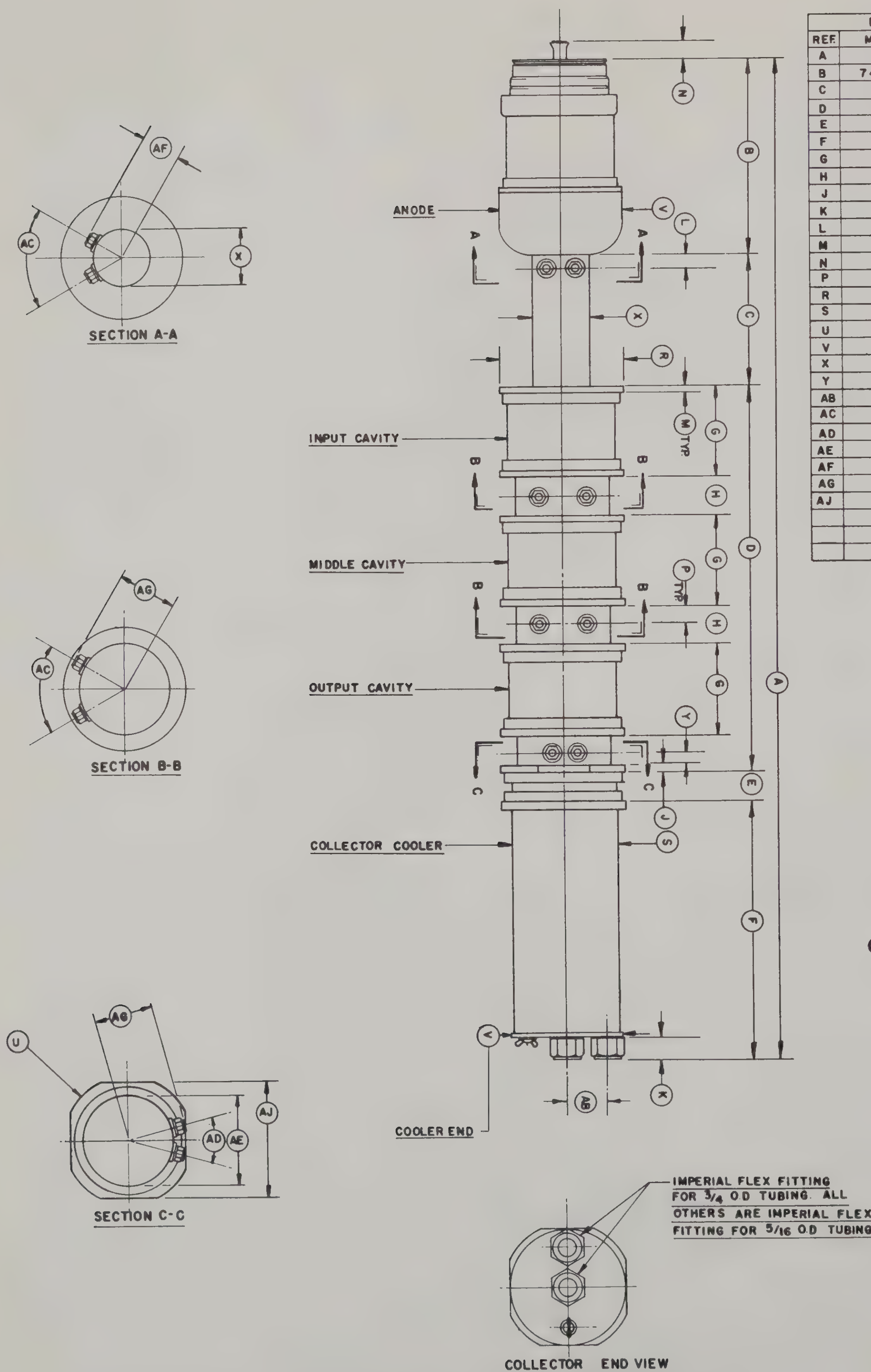
3K50,000LA
OUTLINE DRAWING



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		46.745	46.865
B		7.475	7.510
C		4.490	4.525
D		22.230	22.260
E		1.245	1.270
F		11.285	11.350
G		4.095	5.020
H		1.975	2.005
J		.235	2.55
K		1.055	1.190
L		.495	.550
M		.187	
N	.750		
P		.870	.920
Q		3.730	3.755
R		5.118 DIA.	5.128 DIA.
S		4.490 DIA.	4.505 DIA.
T		.870	.920
U		5.118 DIA.	5.128 DIA.
V		4.620 DIA.	4.630 DIA.
X		2.120 DIA.	2.135 DIA.
Y		.430	.445
AB		1.560	1.630
AC	60°		
AD	30°		
AE		3.495 DIA.	3.510 DIA.
AF	1.875		
AG	2.563		

3K50,000LF
OUTLINE DRAWING

DIMENSION DATA		
REF.	MIN.	MAX.
A	39.875	
B	74375	7.6875
C	5.000	
D	14.875	
E	1.250	
F	11 1875	
G	3 500	
H	1.4375	
J	.250	
K	1.0625	
L	.5625	
M	.250	
N	.750	
P	.719	
R	4.625 DIA	
S	4.500	
U	5.1875 DIA	
V	4.625 DIA	
X	2.125	
Y	.4375	
AB	1.625	
AC	60°	
AD	30°	
AE	3.500	
AF	1.875	
AG	2.5625	
AJ	4.625	

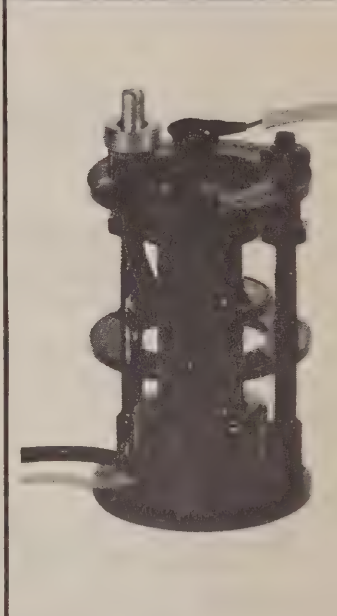


3K50,000LQ
OUTLINE DRAWING

Printed in U.S.A. 45908

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

X481D
KLYSTRON
X-BAND OSCILLATOR



The Eimac experimental tube type X481D is a ruggedized integral-cavity X-band reflex klystron intended for local oscillator service under conditions of severe shock, vibration, or sustained acceleration. The tube will operate satisfactorily at a resonator voltage of 250 volts, a repeller voltage of approximately -100 volts, and with loads having a standing wave ratio as high as 6 db.

The X481D is an experimental type. Samples may be used for experimental or preliminary design work, but should not be made the basis for the final design of equipment without further discussion with the manufacturer.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Coated Unipotential
- Heater Voltage - - - - - - - - - 6.3 volts
- Heater Current - - - - - - - - - 0.80 amp

Frequency - - - - - - - - - - - - 8500-9600 Mc

MECHANICAL

Minimum Axial Acceleration Test - - - - - 200 g
Minimum Axial Vibration Test - - - - - - 10 g
Base - - - - - - - - - - - - - - Special three-hole flange
Connections:
- Heater - - - - - - - - - - - Colored wire at base
- Heater and Cathode - - - - Black wire at base
- Resonator - - - - - - - - Shell of tube
- Repeller - - - - - - - - - Colored wire at top
- Output - - - - - - - - - - - Coaxial fitting at top

Mounting Position - - - - - - - - Any
Cooling - - - - - - - - - - - - - - Convection and radiation
Maximum Overall Dimensions:
- Length - - - - - - - - - - - - - - 2.44 inches
- Diameter - - - - - - - - - - - - - 1.14 inches

Net Weight - - - - - - - - - - - - - - 1.5 ounces
Shipping Weight (Average) - - - - - - - - 4 ounces

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE - - - - - - - - - - - -	300 MAX. VOLTS
D-C CATHODE CURRENT - - - - - - - - - - - -	35 MAX. MA
D-C REPELLER VOLTAGE	
Positive Limit - - - - -	0 MAX. VOLTS
Negative Limit - - - - - -	-500 MAX. VOLTS

TYPICAL OPERATION (With 50-ohm load)

Mode - - - - - - - - - -	A	B	
D-C Resonator Voltage -	250	300	volts
D-C Cathode Current - -	18	24	ma
D-C Repeller Voltage- -	-95	-130	volts
Power Output - - - - - -	20	50	mw
Frequency - - - - - -	9000	9000	Mc.

APPLICATION

Mounting--The X481D is provided with a three-hole base flange for solid mounting directly to the equipment chassis or to an insulating support. No socket or tube clamp is required.

Cooling--No special provisions are ordinarily required for the cooling of the X481D. The resonator will dissipate 10 watts of power by radiation and convection in ambient temperatures up to 100°C.

Resonator--The resonator of the X481D is integral with the shell of the tube. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials. All voltages given in the list of Maximum Ratings and in the Typical Operation data are measured with respect to the cathode of the tube.

Cathode--Heater voltage should be at the rated value of 6.3 volts. Variations should be kept within the range of 5.7 to 6.9 volts. The cathode is internally connected to one side of the heater. If the resonator is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator potential.

Repeller--There will be an optimum repeller voltage for any given output frequency, and the range of electronic tuning or of frequency modulation under control of the repeller voltage will vary with output frequency. These relations are shown for a typical tube in the accompanying curves.

Repeller voltages must be negative with respect to the cathode at all times.

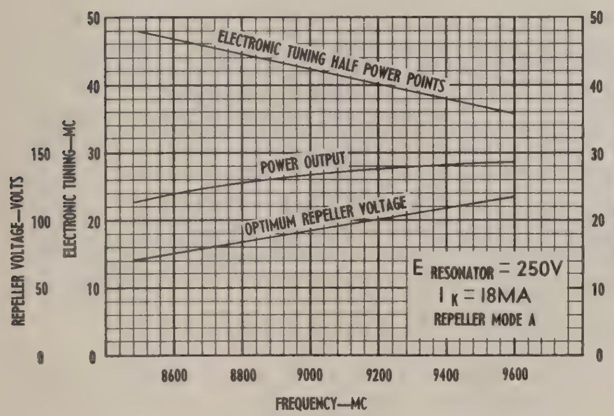
Mechanical Tuning--The mechanical tuning adjustment is rigidly locked in place by three sets of nuts on the tuning structure. Small adjustments in frequency, in the range of plus or minus 200 Mc., may be made with one set. Large frequency changes, however, must be made by equal adjustment of all three. UNDER NO CONDITIONS SHOULD ANY ATTEMPT BE MADE TO TUNE THE X481D BELOW 8300 MC.

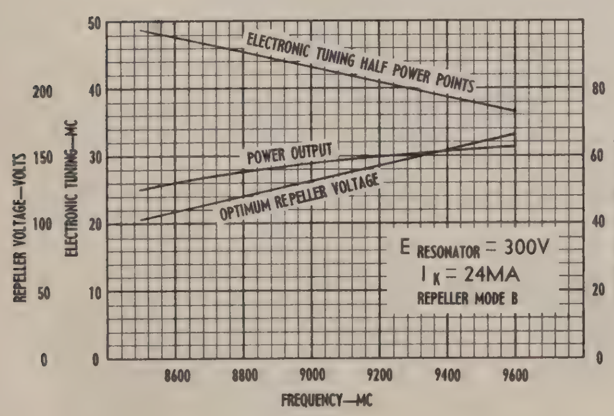
Output--Curves illustrating the variation of Power Output with Operating Frequency for a typical tube are shown herewith. These curves assume a matched load and optimum repeller voltages at all frequencies.

Frequency Stability--The frequency shift of the X481D under constant axial acceleration of 200g is less than 6 Mc. Under vibration of 10g maximum acceleration, the spectrum width is less than 1.0 Mc.

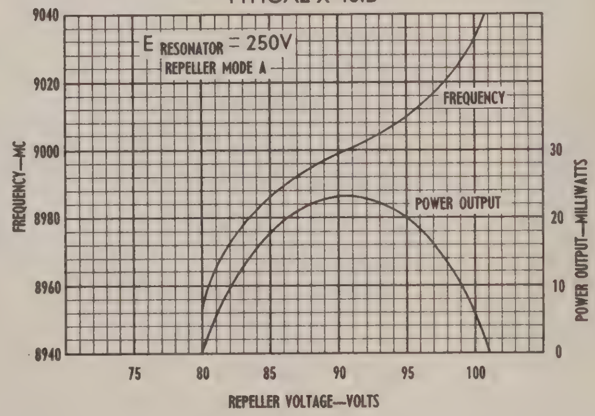
Frequency variations within the range of normal operating temperatures do not exceed ±0.5 Mc/°C.

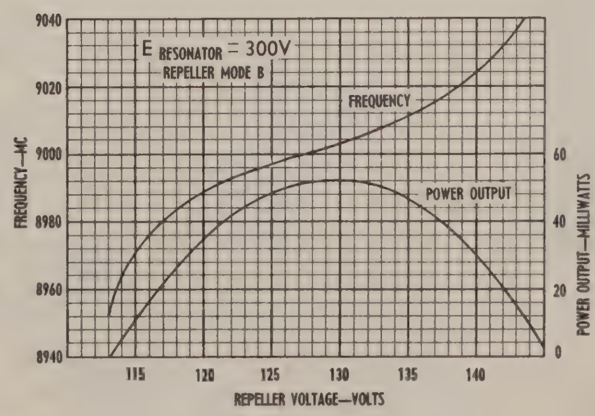
OPERATING CHARACTERISTICS
TYPICAL X-481D



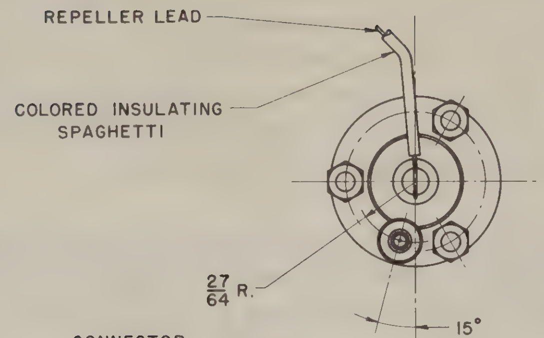


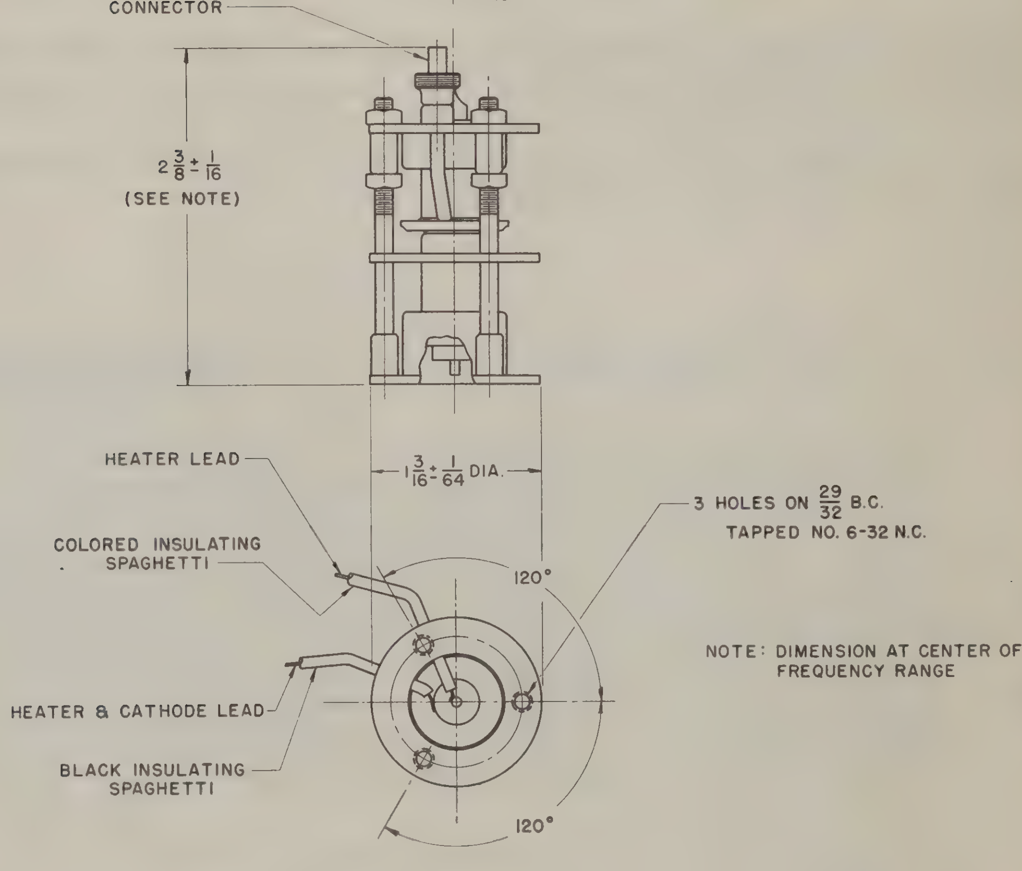
POWER OUTPUT AND FREQUENCY
VS. REPELLER VOLTAGE
TYPICAL X-481D



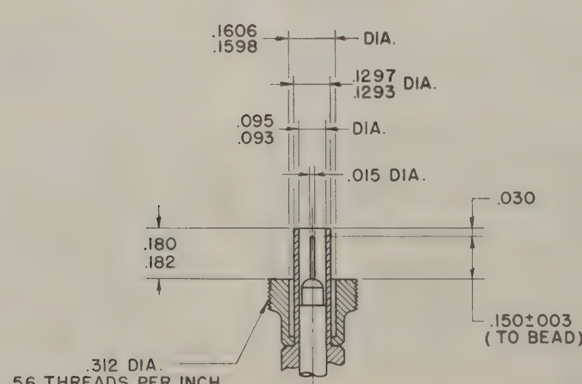


TOP VIEW





BOTTOM VIEW



CONNECTOR DETAIL

Printed in U.S.A. 1-B2-57308

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

3KM50,000PA

POWER-AMPLIFIER P-BAND KLYSTRON

The Eimac 3KM50,000PA is a three-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 225 and 400 megacycles and will deliver a minimum output power of 20 kilowatts CW, or 10 kilowatts AM carrier, with a minimum power gain of 30 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 3KM50,000PA are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-126, for use with the 3KM50,000PA, covers the frequency range of 225 to 400 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, input and output r-f load couplers and an Eimac SK-110 Air-System Socket. The H-126 Klystron Amplifier Circuit Assembly conforms generally to Military Environmental Specification MIL-E-4970A (USAF) and the general Military specification, MIL-E-4158B (USAF), for electronic ground equipment.

CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Heater: Voltage (±5%)		7.5		volts
Current (Normal)	38		42	amperes
Max. Starting Current			80	amperes
Cathode: EMA, Unipotential				
Heating Time	5			minutes
Getter (Operating): Voltage		2.0		volts
Current		36.0		amperes
Power Gain: (Narrow Band)		36		decibels
Output Power: CW	20			kilowatts
AM Carrier (90% Modulated)		10		kilowatts
Frequency Range		225 to 400		megacycles

MECHANICAL

Operating Position - - - -	Vertical, cathode end up
R-F Input Coupling - - - -	50-Ohm Type N, UG-58A
R-F Output Coupling - - - -	50-Ohm, 6-1/8" line
Weight:	
3KM50,000PA - - - -	163 pounds
H-126 Circuit Assembly - - -	1940 pounds

Cooling: Water or 60% Ethylene-Glycol solution and Forced Air

		Flow Rate	Pressure Drop
Cathode (With SK-110 Socket)	-	*25 cfm air	1 inch H_2O
Output Cavity	-	*100 cfm air	2 inches H_2O
Four Drift-Tube Jackets in Series		4 gpm	(see curves)
Collector	-	(see collector cooling curves)	

MAXIMUM RATINGS

	CW	AM	
D-C BEAM VOLTAGE	23.0	30.0	KILOVOLTS
D-C BEAM CURRENT	2.75	2.0	AMPERES
D-C MODULATING ANODE VOLTAGE	23.0	17.0	KILOVOLTS
PEAK MODULATING ANODE VOLTAGE	----	±13.0	KILOVOLTS
D-C FOCUS ELECTRODE VOLTAGE	-500	-500	VOLTS
D-C BODY CURRENT	250	250	MILLIAMPERES
A-C GETTER CURRENT	50	50	AMPERES
COLLECTOR DISSIPATION	60	60	KILOWATTS
SEAL TEMPERATURES	175	175	DEGREES C

TYPICAL OPERATION (In H-126 Circuit Assembly)

NARROW-BAND CW AMPLIFIER, Tuned for Maximum Output Power.

Frequency	300	400	400	400	megacycles
Output Power	24.4	8.93	19.8	23.1	kilowatts
Driving Power	5.0	5.0	5.0	5.0	watts
Power Gain	36.9	32.5	35.9	36.6	decibels
D-C Beam Voltage	23.0	18.0	22.0	23.0	kilovolts
D-C Beam Current	2.6	1.83	2.55	2.6	amperes
Beam Input Power	59.8	32.9	56.0	59.8	kilowatts
Beam Power Efficiency	40.8	27.0	35.2	38.6	percent
D-C Body Current	110	50	80	120	milliamperes
D-C Collector Current	2.49	1.78	2.47	2.48	amperes
Focus Electrode Voltage	-285	-200	-200	-285	volts
Prefocus Coil Current	0.9	0.8	0.9	0.9	ampere

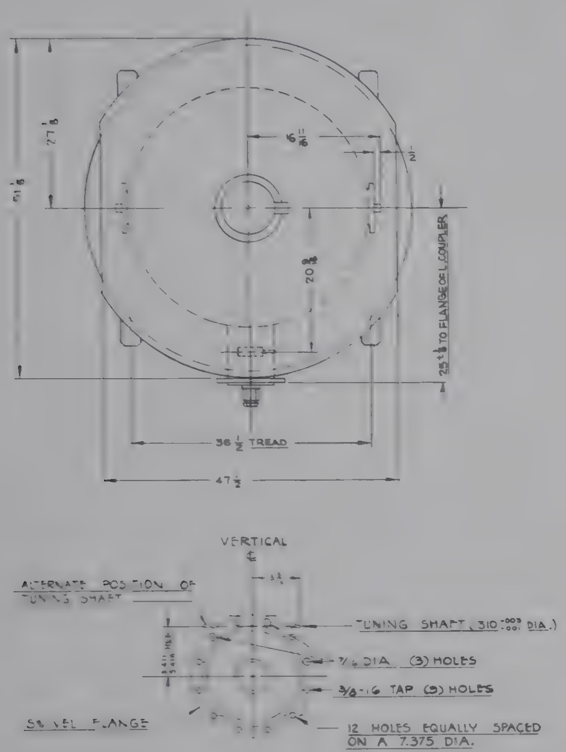
AMPLITUDE MODULATED

Modulation	90	90	percent
Output Power (average)	13.2	14.3	kilowatts
Driving Power	5.3	8.8	watts
Power Gain	32.7	32.1	decibels
D-C Beam Voltage	27.8	29.5	kilovolts
D-C Beam Current	1.74	1.85	amperes
Beam Input Power	48.4	54.6	kilowatts
Beam Power Efficiency (average)	27.2	26.2	percent
D-C Body Current	40	49	milliamperes
D-C Collector Current	1.7	1.8	amperes
Focus Electrode Voltage	-166	-200	volts
D-C Modulating Anode Voltage	16.7	17.0	kilovolts
Total RMS Harmonic Distortion	3.3	3.9	percent

*At sea level with 30° C inlet air temperature.

BODY COIL AND COLLECTOR COIL CURRENTS FOR ALL OPERATING CONDITIONS
(H-126 Assembly)

First Body Coil - - - -	10.0	amperes
Second Body Coil - - - -	12.5	amperes
Third Body Coil - - - -	15.0	amperes
Fourth Body Coil - - - -	17.5	amperes
Collector Coil - - - -	4.5	amperes



END VIEW OF LOAD COUPLER (ITEM #7)

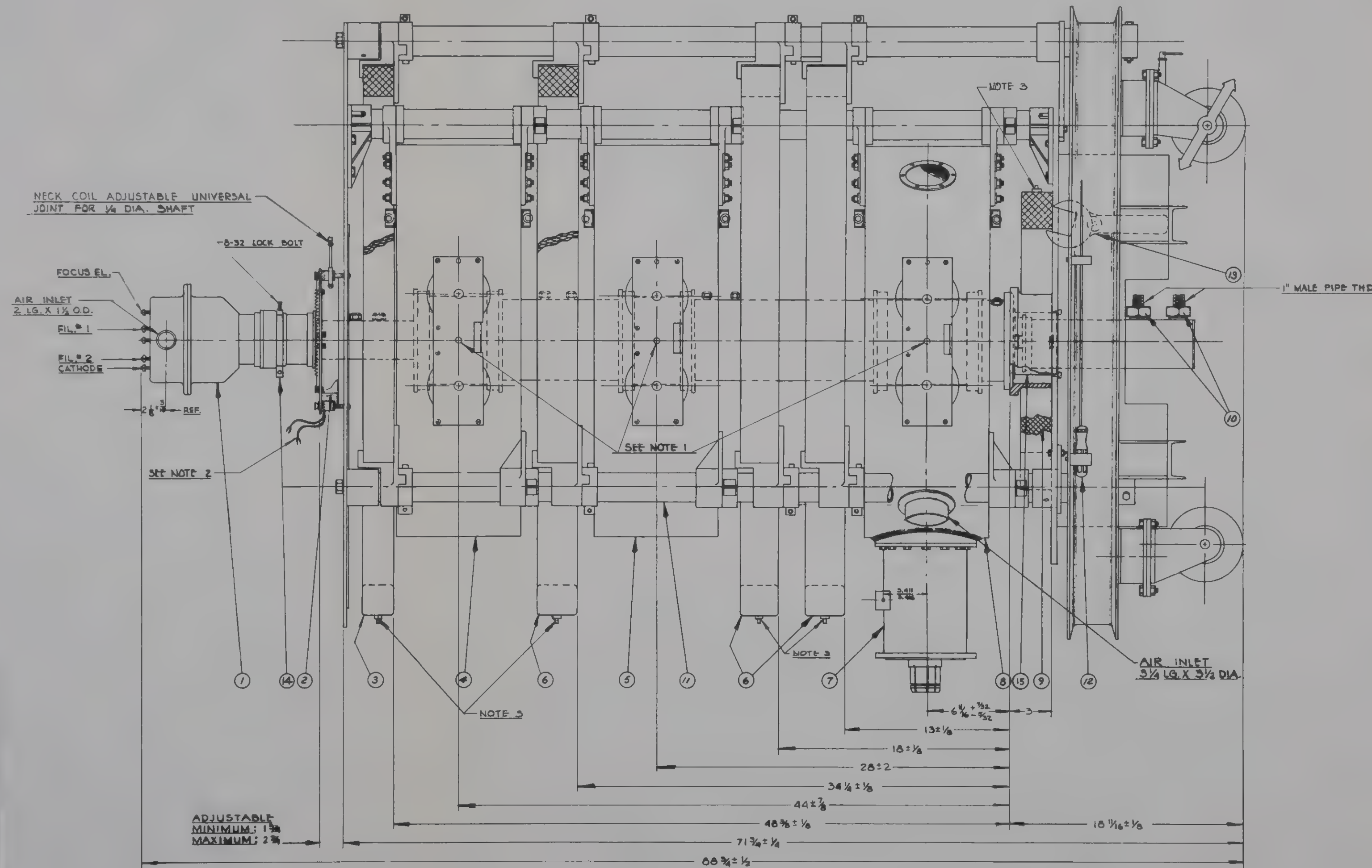
NOTES:
1. TUNING DRIVE, 1⁵⁄₁₆ LG. X .500 DIA.
2. 2 FT. WIRE LEAD WITH SPADE LUGS, AMP 32562
3. AMPHENOL MS-3102A-18-5P RECEPTACLE

ITEM NO.	CATALOG NO. USE FOR REPLACEMENT ORDERING	NAME	REQ
1	SK-0	SOCKET ASSEMBLY	1
2	MC-233	PREFOCUS COIL	1
3	MC-225	TOP BODY COIL	1
4	RF-440	INPUT TUNING BOX	1
5	RF-441	MIDDLE TUNING BOX	1
6	MC-226	BOTTOM BODY COIL	3
7	LC-319	LOAD COUPLER	1
8	RF-442	OUTPUT TUNING BOX	1
9	MC-234	COLLECTOR COIL	1
10	HC-100	COLLECTOR HOSE FITTING	2
11	MF-121	MAGNETIC FRAME	1
12	HT-103	SPECIAL LONG SOCKET WRENCH	1
13	HT-104	WRENCH FOR [illegible]	1
14	SK-112	MODULATING ANODE CONNECTOR	1
15	SK-113	GETTER CLAMP	1

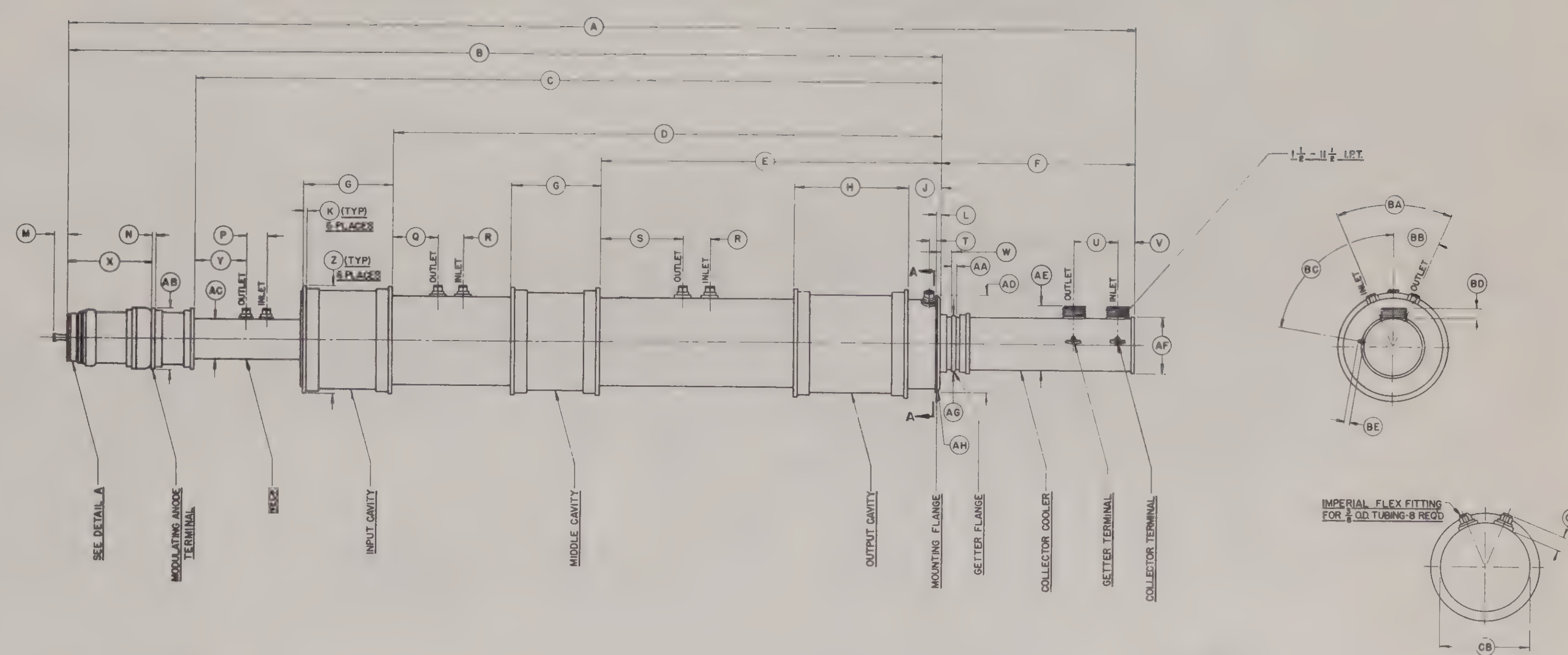
MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS
(Eimac H-126 Klystron Amplifier Circuit Assembly)

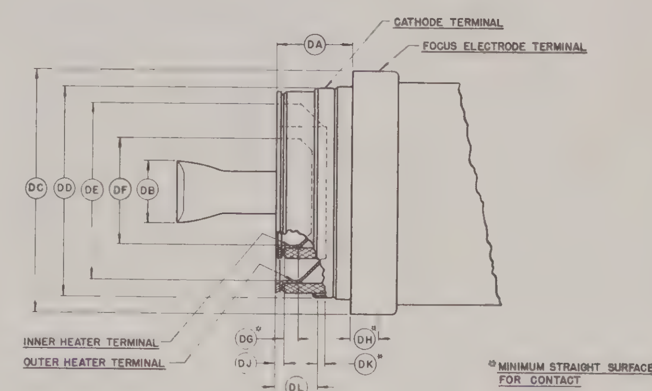
		Min.	Max.	
Prefocus Coil:	Voltage (dc) - -	0	25	volts
	Current (dc) - -	0	2	amperes
Each of Four Body Coils:				
	Voltage (dc) - -	0	40	volts
	Current (dc) - -	0	20	amperes
Collector Coil:				
	Voltage (dc) - -	0	40	volts
	Current (dc) - -	0	6.5	amperes

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.



H-126 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY



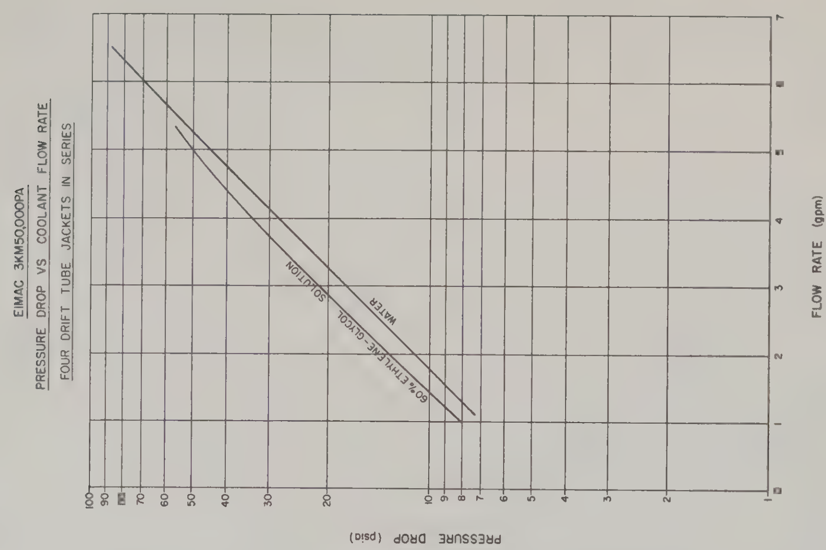


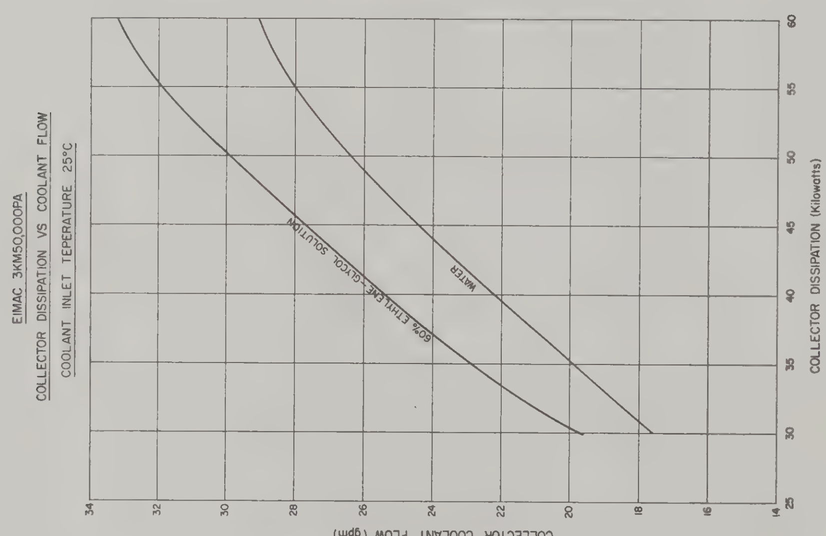
DETAIL A

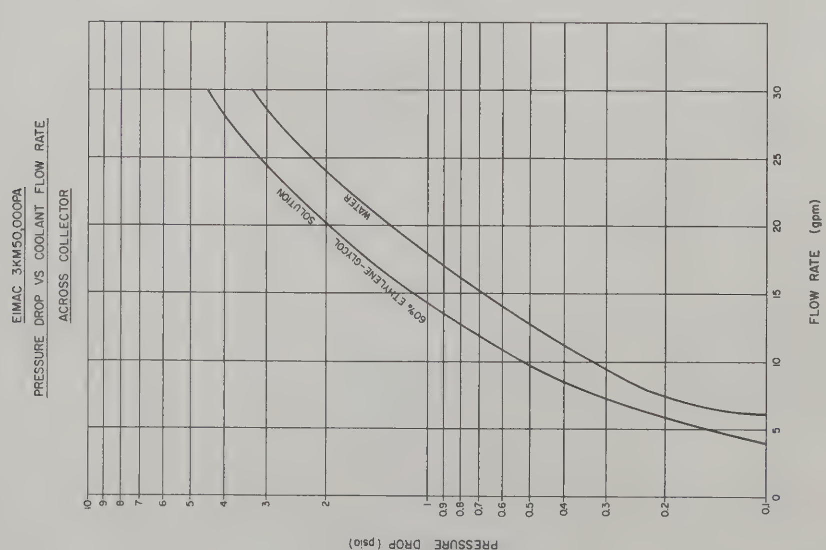
* MINIMUM STRAIGHT SURFACE FOR CONTACT

DIMENSION DATA							
REF	NOM	MIN	MAX	REF	NOM	MIN	MAX
PRE-PRODUCTION				DC		4.300	4.450
A		78.610	80.255	DD		3.750	3.835
P		1.450	1.550	DE		3.100	3.200
Q		3.300	3.400	DF		1.865	1.950
R		1.900	2.150	DG		.100	
S		6.550	6.650	DH		.100	
T		.400	.480	DJ		.125	.175
U		3.200	3.300	DK		.100	
V		1.100	1.300	DL		670	.775
Y		3.800	4.000	PRODUCTION			
AE		4.875	5.125	B		64.360	65.505
AF		4.165	4.215	C		55.260	55.860
BA		40°	50°	D		40.475	41.100
BB		17.5°	27.5°	E		25.100	25.500
BC		75°	85°	F		14.250	14.750
BD		.600		G		6.700	6.800
BE		.450	.550	H		8.650	8.800
CA		900	1.125	J		2.300	2.400
CB		6.625	7.000	M			1.750
DESIGN				W		800	.865
K		.355	.395	X		6.190	6.320
L		.335	.365	Z		8.110	8.140
N		235	.265	AB		4.610	4.640
AA		.225	.275	AD		8.110	8.140
AC		3.100	3.150	DA		1.000	1.500
AG		4.240	4.290	DB			1.188
AH		.475 R.	.525 R.				

3KM50000PA KLYSTRON







Printed in U.S.A. 856

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM50,000LA

POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM50,000LA is a four-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 400 and 610 megacycles and will deliver a minimum CW output power of 10 kilowatts with a minimum power gain of 50 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits or when grounded through a resistor.

The resonant cavities for the 4KM50, 000LA are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

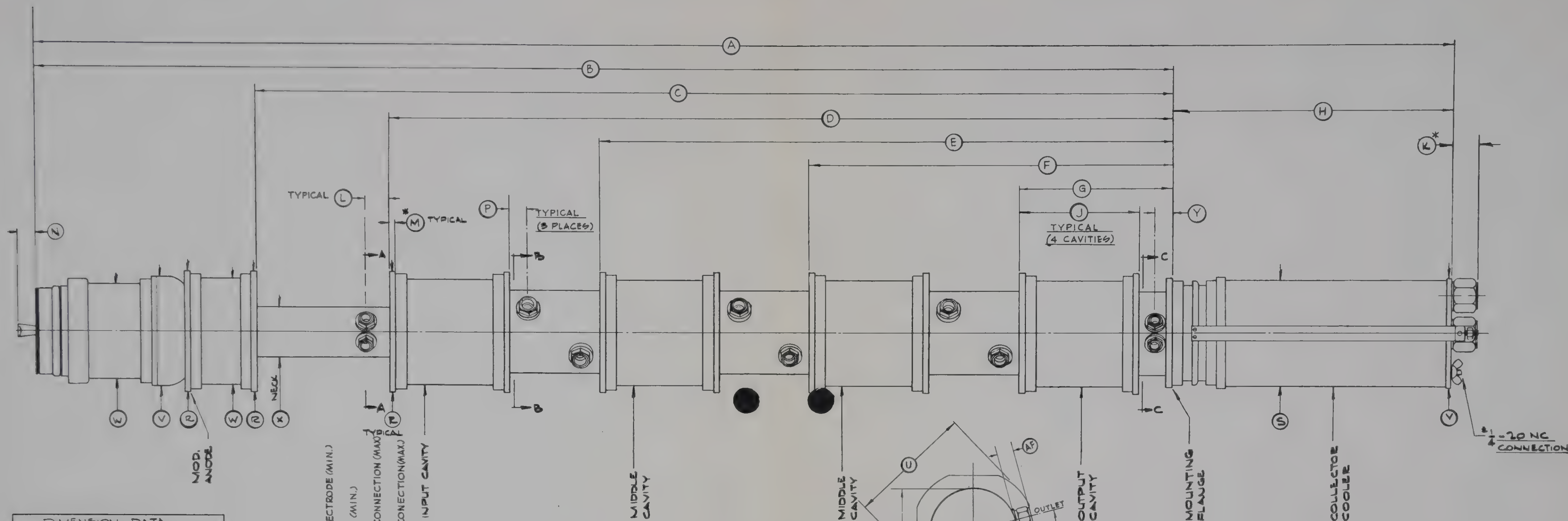
Eimac Klystron Amplifier Circuit Assembly H-121, for use with the 4KM50, 000LA, covers the frequency range of 400 to 610 megacycles. This assembly includes a klystron supporting structure, electro-magnetic focusing coils, tuning boxes, adjustable load couplers for the second, third and output cavities, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

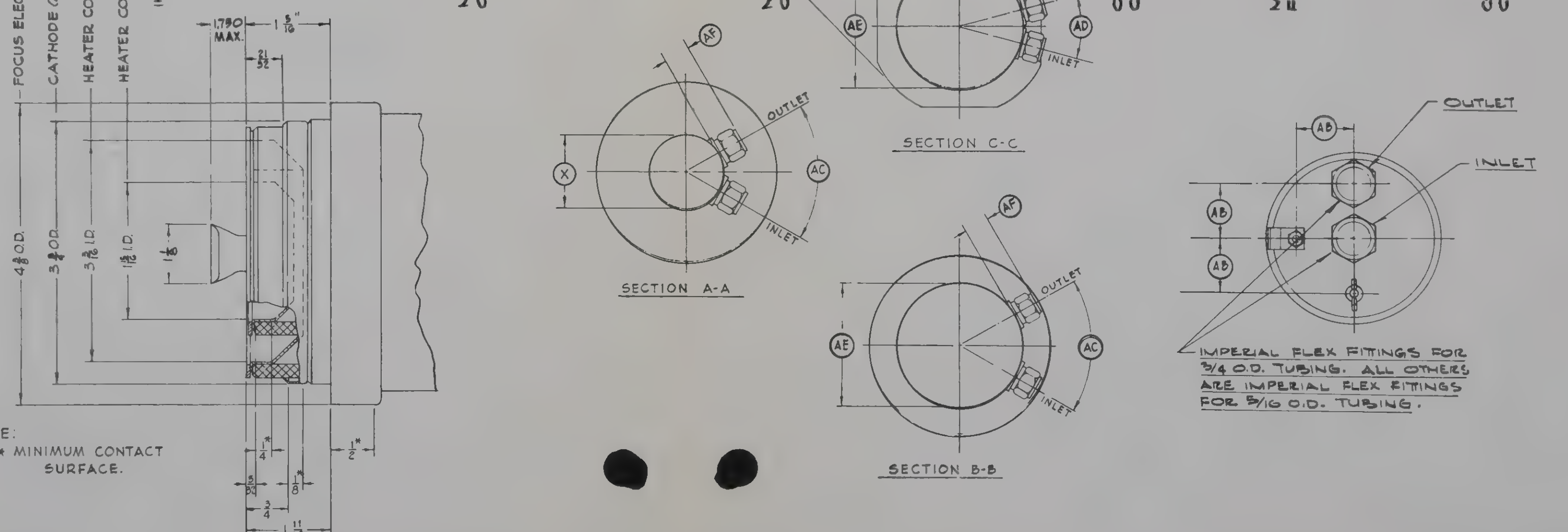
ELECTRICAL

Heater:	Voltage - - -	7.5	volts
	Current - - -	40.0	amperes
	Maximum Starting Current	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time - -	5	minutes
Getter (Operating):			
	Voltage - - -	2.0	volts
	Current - - -	36.0	amperes
Power Gain:	(Narrow Band) - -	50	decibels
Output Power	- - - -	10	kilowatts
Frequency Range	(H-121 Assembly)	400 to 610	megacycles

4KM50,000LA



REF	NOM.	MIN.	MAX.
A		63.901	64.409
B		52.447	52.863
C		43.251	43.597
D		37.798	38.104
E		27.679	27.917
F		17.561	17.731
G		7.444	7.544
H		11.429	11.569
J		5.987	6.045
K		1.000	1.150
L		.977	.997
M		.245	.255
N			1.750
P		.832	.862
R		5.120	5.130
S		4.495	4.505
U		5.120	5.130
V		4.610	4.640
W		3.998	4.002
X		2.115	2.125
Y		.395	.469
AB		1.610	1.640
AC		50°	70°
AD		20°	40°
AE		3.495	3.505
AF		.839	.879



NOTE:
* MINIMUM CONTACT SURFACE.

4KM50,000LA OUTLINE DRAWING

MECHANICAL

Operating Position	Axis vertical, cathode up	
R-F Coupling:		
Input	Type "N" coaxial fitting	
Output	3 1/8 inch 50 ohm line	
Input Cavity Loading	Type "N" coaxial fitting	
2nd and 3rd Cavity Loading	1 5/8 inch 50 ohm line	
Shipping Weights:		
4KM50,000LA Klystron Only	64 lbs (Net)	
	155 lbs (Gross)	
H-121 R-F Circuit Assembly	767 lbs (Net)	
	1084 lbs (Gross)	

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series)	1 gpm	28 psia
Klystron Collector	25 gpm	28 psia

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil:	Voltage	0 to 50	volts
	Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:			
	Voltage	0 to 500	volts
	Current	0 to 2.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20	KILOVOLTS
D-C Beam Current	2.5	AMPERES
D-C BODY CURRENT (CONTINUOUS)	100	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS

TYPICAL OPERATION, NARROW BAND, CW AMPLIFIER

Frequency	400	610	megacycles
Output Power	13.1	12.0	kilowatts
Driving Power	.050	.050	watts
Power Gain	54	53.8	decibels
D-C Beam Voltage	17	17	kilovolts
D-C Beam Current	1.8	1.8	amperes
Beam Power Efficiency	42.8	39.2	percent
D-C Body Current	90	80	milliamperes
D-C Collector Current	1.71	1.72	amperes
Focus-Electrode Voltage	-201	-211	volts
Magnetic-Coil Currents (H-121 Components):			
Prefocus Coil	1.0	0.97	ampere
Three Body Coils and Collector Coil in Series	2.0	2.0	amperes

* At Sea level with 20° C inlet air temperature.

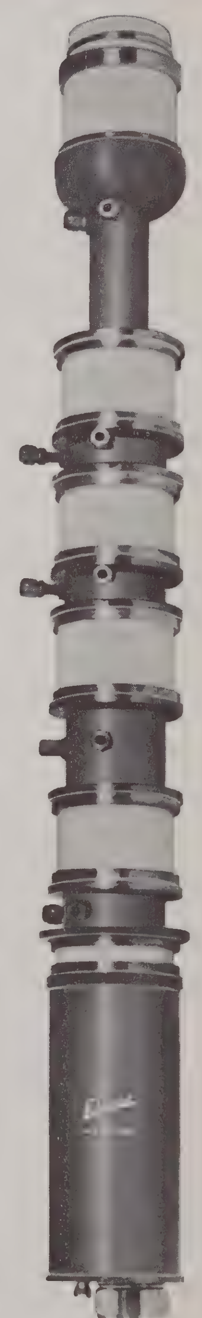
For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

4K50,000LQ

POWER AMPLIFIER L-BAND KLYSTRON



The Eimac 4K50,000LQ is a ceramic and metal, four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 600 and 985 megacycles. It will deliver a minimum CW output power of 10 kilowatts with a power gain of more than 55 db. In applications requiring a 6-megacycle bandwidth at the 0.5-db power points, the 4K50,000LQ will deliver 10 kilowatts output power with a power gain of 30 db.

The resonant cavities for the 4K50,000LQ are completed through the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-101A) has been designed for use with this tube and covers the frequency range of 720 to 985 megacycles. Other frequency ranges can be provided if required. This assembly includes an electromagnetic frame and coils, external tuning boxes, an adjustable output coupler, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Filament: Pure Tungsten			
	Voltage	8.0	volts
	Current	40	amperes
	Maximum Starting Current	80	amperes
Cathode: Unipotential, Bombardment Heated			
	Voltage	2250	volts
	Current	0.71	ampere
	Power	1600	watts
Power Gain:			
	Narrow Band	55	db
	Broad Band (6 mc at 0.5-db points)*	30	db
Output Power		10,000	watts
Frequency Range (In H-101A Assembly)		720 to 985	mc

*(9 mc at 3-db points)

MECHANICAL

Operating Position	Vertical, cathode end up
R-F Input Coupling	Type "N" coaxial fitting
R-F Output Coupling	3 1/8-inch 50-ohm air line
Net Weight	53 pounds
Shipping Weight (approximate)	135 pounds

Cooling: Water and Forced Air	Flow Rate	Pressure Drop
Cathode (With SK-110)	52 cfm air	5 inches H_2O
Output Cavity	50 cfm air	1.5 inches H_2O
Body	1 gpm water	8 psi
Collector	25 gpm water	28 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil Voltage	0 to 25	volts
Prefocus-Coil Current	0 to 1	ampere
Each of Three Body Coils:		
Voltage	0 to 175	volts
Current	0 to 3	amperes
Collector-Coil Voltage	0 to 50	volts
Collector-Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20 MAX.	KILOVOLTS
D-C BEAM CURRENT	2.5 MAX.	AMPERES
D-C BODY CURRENT (CONTINUOUS)	0.1 MAX.	AMPERE
D-C BODY CURRENT (TUNING ONLY)	0.15 MAX.	AMPERE
FOCUS-ELECTRODE VOLTAGE	-500 MAX.	VOLTS
BOMBARDED CATHODE:		
D-C VOLTAGE	2.4 MAX.	KILOVOLTS
D-C CURRENT	0.75 MAX.	AMPERE
D-C POWER	1.6 MAX.	KILOWATTS
COLLECTOR DISSIPATION	50 MAX.	KILOWATTS

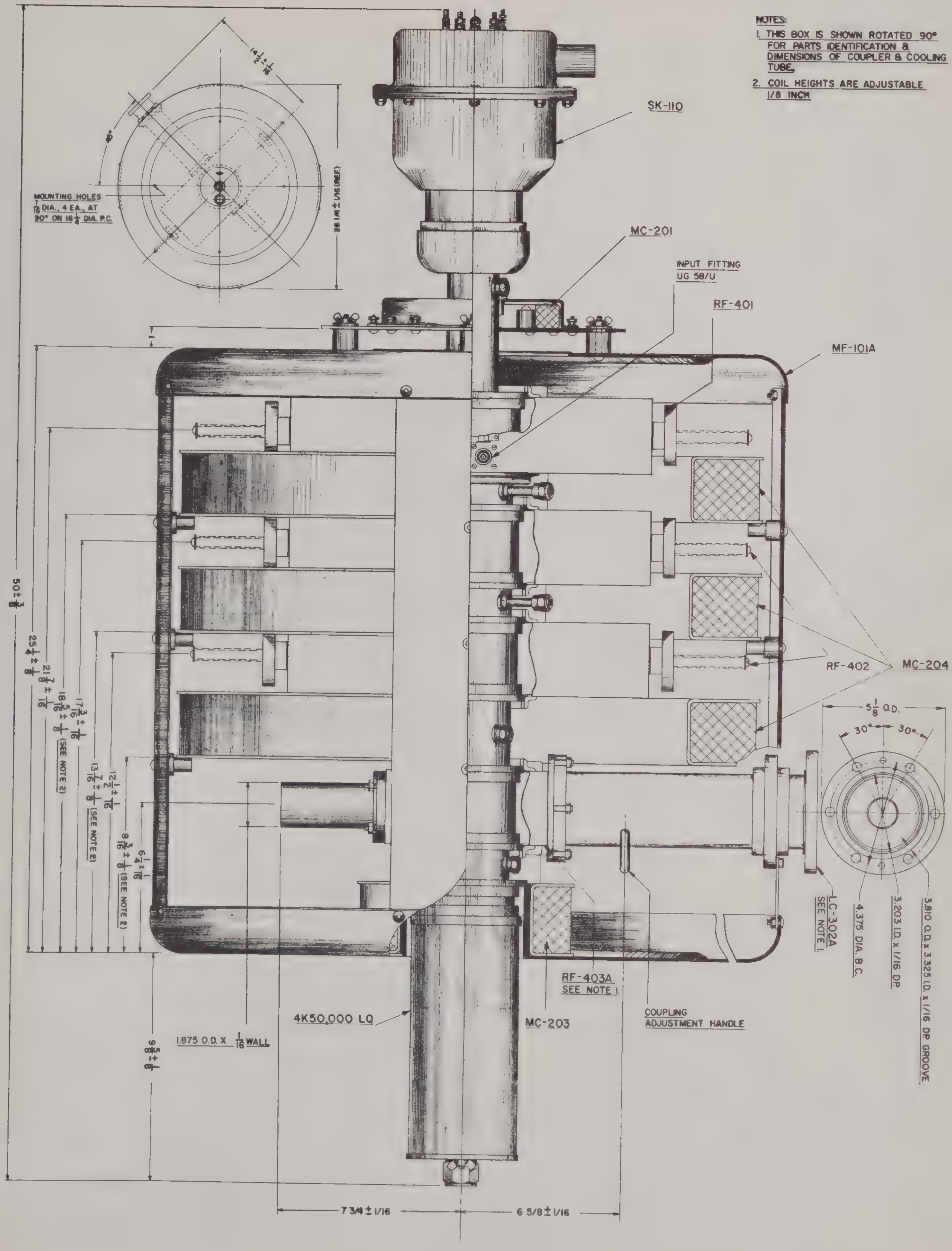
TYPICAL OPERATION

Frequency	900	900	megacycles
Output Power	10.15	11.2	kilowatts
Bandwidth (0.5-db power points)	6.85	1.05	megacycles
Driving Power	5	0.02	watts
Power Gain	33	57.5	db
D-C Beam Voltage	17	16	kilovolts
D-C Beam Current	1.78	1.59	amperes
Beam Input Power	30.2	25.4	kilowatts
Beam Power Efficiency	33.6	44.1	percent
D-C Body Current	80	80	milliamperes
D-C Collector Current	1.7	1.51	amperes
Collector Dissipation*	11.51	12.92	kilowatts
Focus-Electrode Voltage	-200	-200	volts
Filament Voltage	8.0	8.0	volts
Filament Current	40	40	amperes
Bombarded Cathode:			
Voltage*	2250	2250	volts
Current*	0.71	0.71	ampere
Power	1600	1600	watts
Magnetic-Coil Currents:* (Using H-101A Components)			
Prefocus	0.8	0.75	ampere
First Body	1.2	1.2	amperes
Second Body	1.9	1.8	amperes
Third Body	2.5	2.3	amperes
Collector	0.85	0.85	ampere

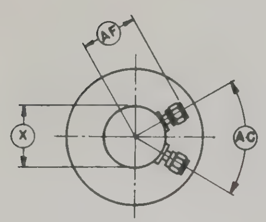
*Approximate values.

APPLICATION

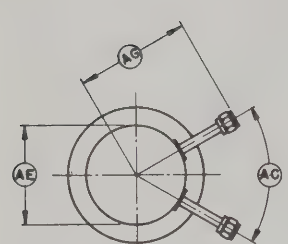
For additional information or information regarding any specific application, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially and without charge.



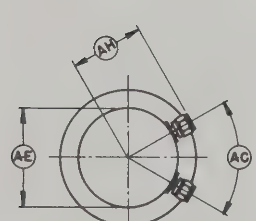
H-101A
KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY



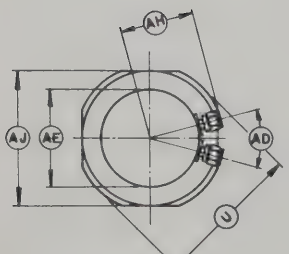
SECTION A-A



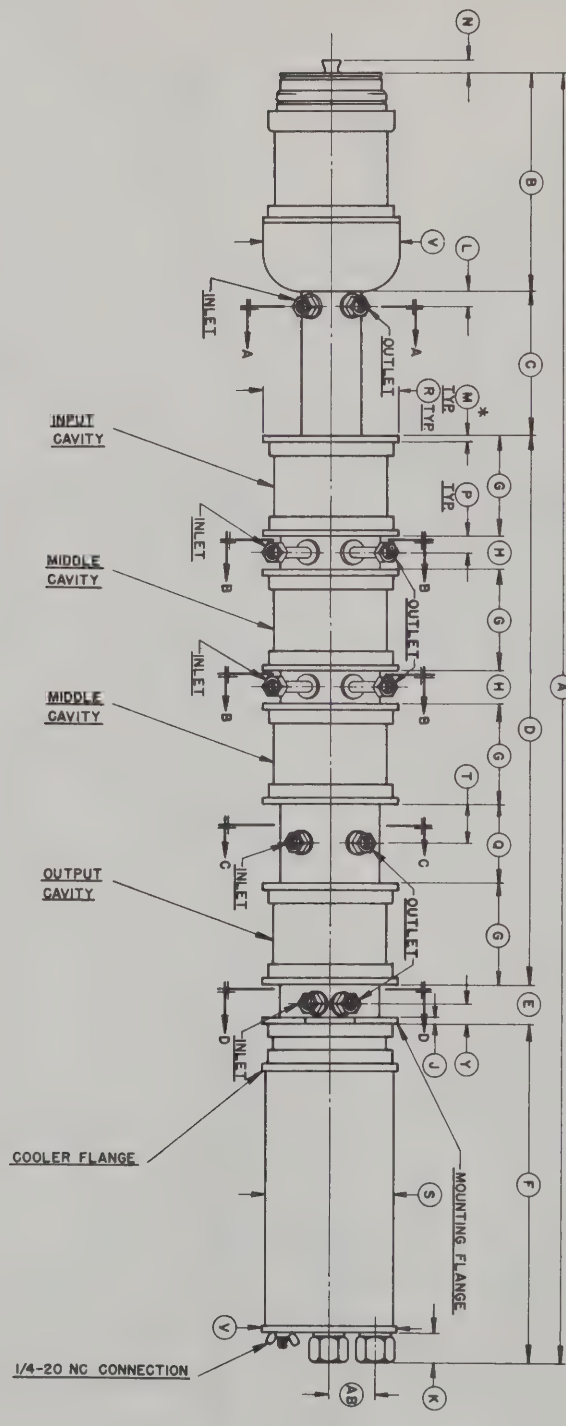
SECTION B-B



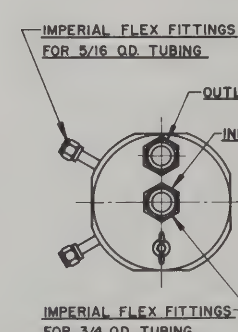
SECTION C-C



SECTION D-D



DIMENSION DATA			
REF	NOM.	MIN.	MAX.
A		44.560	44.690
B		7.470	7.510
C		4.985	5.040
D		19.994	20.064
E	.626		
F		12.515	12.620
G		3.495	3.530
H		1.170	1.205
J		.230	.255
K		1.030	1.100
L		.515	.645
M		.187	
N		.750	
P		.560	.650
Q		2.735	2.770
R		4.610 D	4.630 D
S		4.490 D	4.510 D
T		1.320	1.425
U		5.115 D	5.130 D
V		4.610 D	4.640 D
X		2.120	2.140
Y		.645	.705
AB		1.585	1.630
AC	60°		
AD	30°		
AE		3.485	3.510
AF	1.875		
AG	4.000		
AH	2.563		
AJ		4.615	4.635



4K50,000LQ
OUTLINE DRAWING

NOTES:
1. *MINIMUM CONTACT SURFACES FOR ALL CAVITY PLATES.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. 2 OUTLINE, DRWG. NO. GUN NO. 2-6001.

Printed in U.S.A. 46915

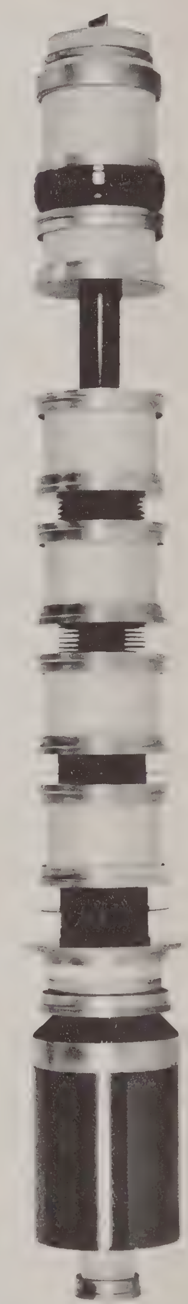
Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

4KM3000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM3000LQ is a four-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 710 and 985 megacycles and will deliver a minimum CW output power of two kilowatts with a minimum power gain of 25 decibels when operated at 50% collector depression.

The collector is designed to operate at less than the cathode to anode voltage, thereby realizing an improvement in efficiency.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 4KM3000LQ are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals,

Eimac Klystron Amplifier Circuit Assembly H-118, for use with the 4KM3000LQ, covers the frequency range of 710 to 985 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, output r-f load coupler and an Eimac SK-100 Air-System Socket.

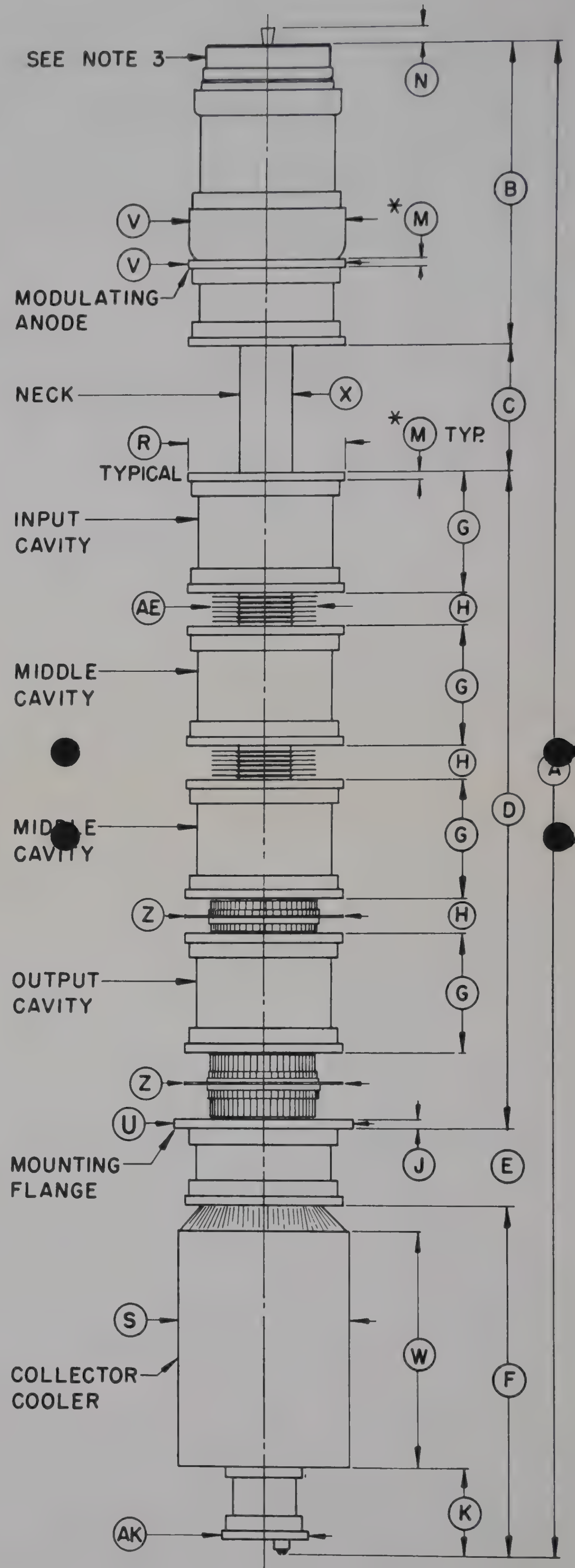
CHARACTERISTICS

ELECTRICAL

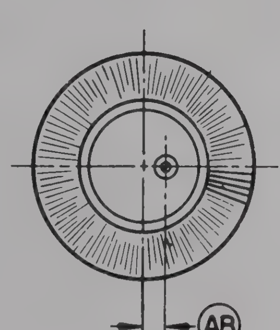
Cathode, Unipotential, Oxide Coated		
Minimum Heating Time - - -	5	minutes
Heater: Voltage - - -	5	volts
Current - - -	33	amperes
Maximum Starting Current -	65	amperes
Modulating Anode Capacitance (To other electrodes) - - -	21	uuf
Power Gain (Narrow Band CW) - -	25	decibels
Output Power (Narrow Band CW) -	2000	watts
Frequency Range (In H-118 Circuit Assembly) -	710 to 985	megacycles

4KM3000LQ

DIMENSIONS			
REF.	NOM.	MIN.	MAX.
A	44.187		
B	8.781		
C	3.750		
D	19.250		
E	2.125		
F	10.265		
G	3.500		
H	1.000		
J	.250		
K	2.578		
M		.187	
N		.650	1.000
R	4.625 DIA.		
S	5.135 DIA.		
U	5.375 DIA.		
V	4.625 DIA.		
W	6.937		
X	1.500 DIA.		
Z	4.625 DIA.		
AB	.500		
AE	3.078 DIA.		
AK	2.500 DIA.		



NOTES
1. *MINUMUM CONTACT SURFACE.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. I OUTLINE, DRWG. NO. GUN NO. I – 6001.



COLLECTOR COOLER
END VIEW

4KM3000LQ OUTLINE DRAWING

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling	
Input	Type "N" coaxial fitting
Output	1-5/8 inch 50-ohm line
Shipping Weights:	
Klystron Only	49 lbs (Net); 138 lbs (Gross)
H-118 R-F Amplifier Circuit Assembly	327 lbs (Net); 473 lbs (Gross)

Cooling:

The 4KM3000LQ is cooled by forced air. At sea level and with inlet air temperature of 20°C (68°F) the flow rates tabulated below are sufficient for operation at maximum ratings and at maximum collector depression of 50%.

Cathode (with SK-100 Air-System Socket)	5 cfm
Penultimate Cavity	50 cfm
Output Cavity	75 cfm
Collector	150 cfm

Operation at higher altitudes or with higher inlet temperatures requires increased volumes of air flow to obtain equivalent cooling.

MAGNETIC-COIL POWER SUPPLY-REQUIREMENTS

Prefocus Coil Voltage	0 to 50	volts
Prefocus Coil Current	2.0	amperes
Each of Three Body Coils		
Voltage	0 to 100	volts
Current	3.0	amperes
Collector Coil Voltage	0 to 50	volts
Collector Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	10,000	VOLTS
D-C BEAM CURRENT	0.750	AMPERE
D-C FOCUS ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	3000	WATTS
SEAL TEMPERATURES	175	DEGREES C

TYPICAL OPERATION - NARROW BAND CW AMPLIFIER - COLLECTOR DEPRESSED

Frequency	900	megacycles
Output Power	2150	watts
Driving Power	4.0	watts
Power Gain	27	decibels
D-C Beam Voltage	9000	volts
D-C Beam Current	0.580	amperes
D-C Collector Voltage (from Cathode)	4500	volts
D-C Collector Current	0.210	amperes
D-C Body Current	0.370	amperes
Focus Electrode Voltage	-200	volts
Efficiency	50.0	percent

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

Printed in U.S.A. 890

TENTATIVE DATA

4KM3000LR

POWER AMPLIFIER

L-BAND KLYSTRON

Eimac®

EITEL-McCULLOUGH, INC.

SAN BRUNO · CALIFORNIA

The Eimac 4KM3000LR is a four-cavity, magnetically-focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 610 and 985 megacycles and under narrow-band conditions will deliver a minimum CW output power of 2 kilowatts with a power gain of at least 45 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits or when grounded through a resistor.

The resonant cavities for the 4KM3000LR are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-125, for use with the 4KM-3000LR, covers the frequency range of 610 to 985 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable load couplers for the input, second, penultimate and output cavities, and an SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Minimum Heating Time	5	minutes
Heater: Voltage (5%)	5.0	volts
Current	31.0	amperes
Maximum Starting Current	65.0	amperes
Typical Power Gain (Narrow Band)	45	db
Minimum Output Power (Narrow Band)	2000	watts
Frequency Range (H-125 Assembly)	610 to 985	Mc

MECHANICAL

Operating Position (H-125 Assembly)	Vertical, cathode end up
R-F Coupling:	
Input	Type "N" 50-ohm receptacle
Input Cavity Loading	Type "N" 50-ohm receptacle
Second Cavity Loading	Type "N" 50-ohm receptacle
Penultimate Cavity Loading	Type "N" 50-ohm receptacle
Output	1-5/8 inch 50-ohm line

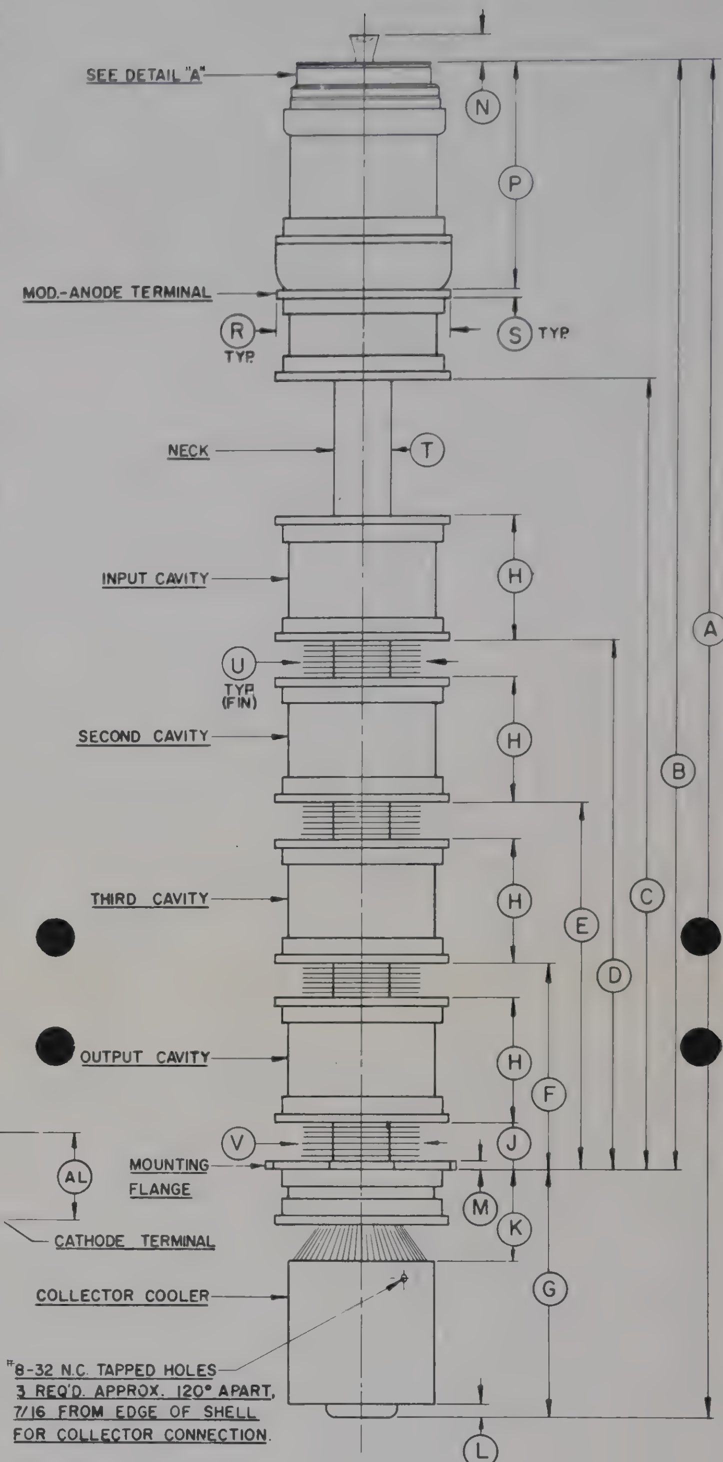
Cooling: (20° C inlet air at sea level)

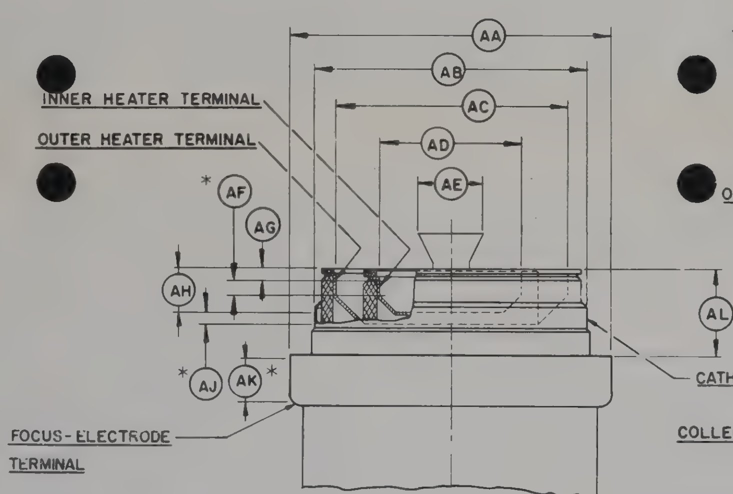
	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	5 cfm	0.4 inch H_2O
Penultimate Cavity	50 cfm	0.9 inch H_2O
Output Cavity	50 cfm	0.9 inch H_2O
Collector	150 cfm	1.8 inches H_2O

Maximum Over-All Dimensions:	
Length	38-1/2 inches
Diameter	5-1/8 inches
Net Weight	38 pounds
Shipping Weight (Approximate)	90 pounds

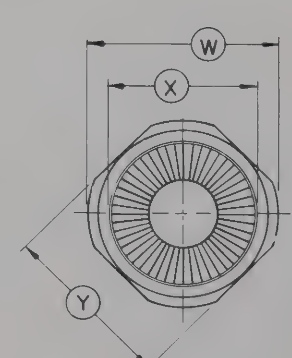
DIMENSIONAL DATA					
REF.	MIN.	MAX.	REF.	MIN.	MAX.
A	36.500	37.000	AA	4.300	4.450
B	30.800	31.000	AB	3.750	3.835
C	22.000	22.150	AC	3.100	3.200
D	14.750	14.900	AD	1.865	1.950
E	10.250	10.375	AE		1.000
F	5.750	5.875	AF	.100	
G	5.825	5.975	AG	.125	.175
H	3.490	3.540	AH	.670	.775
J	1.240	1.370	AJ	.100	
K	2.675	2.825	AK	.500	
L		.750	AL	1.000	1.500
M	.230				
N		1.500			
P	6.200	6.350			
R	4.610	4.635			
S	.240				
T	1.475	1.520			
U	3.080 (NOM)				
V	3.580 (NOM)				
W	5.115	5.135			
X	4.115	4.145			
Y	4.630 (NOM.)				

NOTES:
1. DIMENSIONS IN INCHES.
2. *MINIMUM CONTACT SURFACES.





DETAIL "A"



4KM3000LR OUTLINE DRAWING

MAXIMUM RATINGS

D-C BEAM VOLTAGE *	10	KILOVOLTS
D-C BEAM CURRENT*	0.750	AMPERE
D-C BODY CURRENT (CONTINUOUS)	75	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	100	MILLIAMPERES
FOCUS ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	3000	WATTS
TUBE TEMPERATURES	175	DEGREES C

*These ratings are not to be applied simultaneously.

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil Voltage	0 to 50	volts
Prefocus-Coil Current	0 to 1.25	amperes
Three Body Coils and Collector Coil in Series:		
Voltage	0 to 350	volts
Current	0 to 2.25	amperes

TYPICAL OPERATION

Narrow-Band, CW Amplifier (In H-125 Circuit Assembly)

Frequency	900	megacycles
Output Power	2100	watts
Driving Power	0.050	watt
Power Gain	46	db
D-C Beam Voltage	8500	volts
D-C Beam Current	0.550	ampere
Beam Input Efficiency	45	percent
D-C Body Current	50	milliamperes
D-C Collector Current	0.500	ampere
Focus-Electrode Voltage	-200	volts
Magnetic-Coil Currents **		
Prefocus	0.65	ampere
Body Coils and Collector Coil in Series	1.75	amperes

** Approximate values

In the event of loss of driving power, the collector dissipation rating of the 4KM3000LR may be exceeded. Therefore, the collector should be fitted with a thermal overload device, interlocked with the beam control circuitry, and set to operate at a collector temperature equal to or greater than 175° Centigrade.

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially.

Printed in U.S.A. 919

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA
4KM170,000LA
POWER AMPLIFIER
L-BAND KLYSTRON

The Eimac 4KM170,000LA is a four-cavity, magnetically-focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 325 and 500 megacycles and under narrow-band conditions will deliver a minimum CW output power of 75 kilowatts with a power gain of at least 45 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 4KM170,000LA are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-142 for use with the 4KM170,000LA, covers the frequency range of 325 to 500 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an Eimac Air-System Socket. The H-142 Klystron Amplifier Circuit Assembly conforms generally to Military Environmental Specification MIL-E-4970A (USAF) and the general Military Specification, MIL-E-4158B (USAF), for electronic ground equipment.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage (±5%) - -	11	volts
	Current - - -	23	amperes
	Maximum Starting Current -	50	amperes
Cathode:	EMA, Unipotential		
	Heating Time - -	5	minutes
Getter (Operating):			
	Voltage (Nominal) - -	9.1	volts
	Current - - -	36	amperes
Power Gain: (Narrow-Band) - -		45	decibels
Minimum Output Power (CW) -		75,000	watts
Frequency Range (H-142 Circuit Assembly)		325 to 500	megacycles

MECHANICAL

Operating Position	Vertical, cathode end up
R-F Input Coupling	Type "N" coaxial fitting
R-F Output Coupling	50-ohm, 6 1/8" line
Weight (Tube Only)	196 pounds
Shipping Weight (Approximate)	410 pounds

Cooling: Water or 60% Ethylene-Glycol Solution and Forced Air

	Flow Rate	Pressure Drop
Cathode	*50 cfm air	1 inch H_2O
Output Cavity	*50 cfm air	6 inches H_2O
Five Drift-Tube sections in series	10 gpm	See curves
Collector	50 gpm	See curves

MAXIMUM RATINGS

D-C BEAM VOLTAGE	35	KILOVOLTS
D-C BEAM CURRENT	5	AMPERES
D-C FOCUS ELECTRODE VOLTAGE	-1000	VOLTS
D-C BODY CURRENT	250	MILLIAMPERES
COLLECTOR DISSIPATION	170	KILOWATTS
A-C GETTER CURRENT	50	AMPERES
SEAL TEMPERATURES	175	DEGREES C

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

		Min.	Max.	
Prefocus Coil:	Voltage	0	25	volts
	Current	0	2	amperes
Each of Three Body Coils				
	Voltage	0	25	volts
	Current	0	15	amperes
Collector Coil:	Voltage	0	25	volts
	Current	0	6	amperes

TYPICAL OPERATION, CW AMPLIFIER

Frequency	325	400	500	megacycles
Output Power	75.5	80.5	77	kilowatts
Driving Power	0.8	0.5	0.5	watt
Power Gain	49.7	52.1	51.9	decibels
Power Input	185	185	185	kilowatts
D-C Beam Voltage	35	35	35	kilovolts
D-C Beam Current	5.28	5.28	5.28	amperes
Beam Efficiency	40.8	43.5	41.7	percent
D-C Body Current	220	190	210	milliamperes
D-C Collector Current	5.06	5.09	5.17	amperes
Focus Electrode Voltage	-400	-400	-400	volts

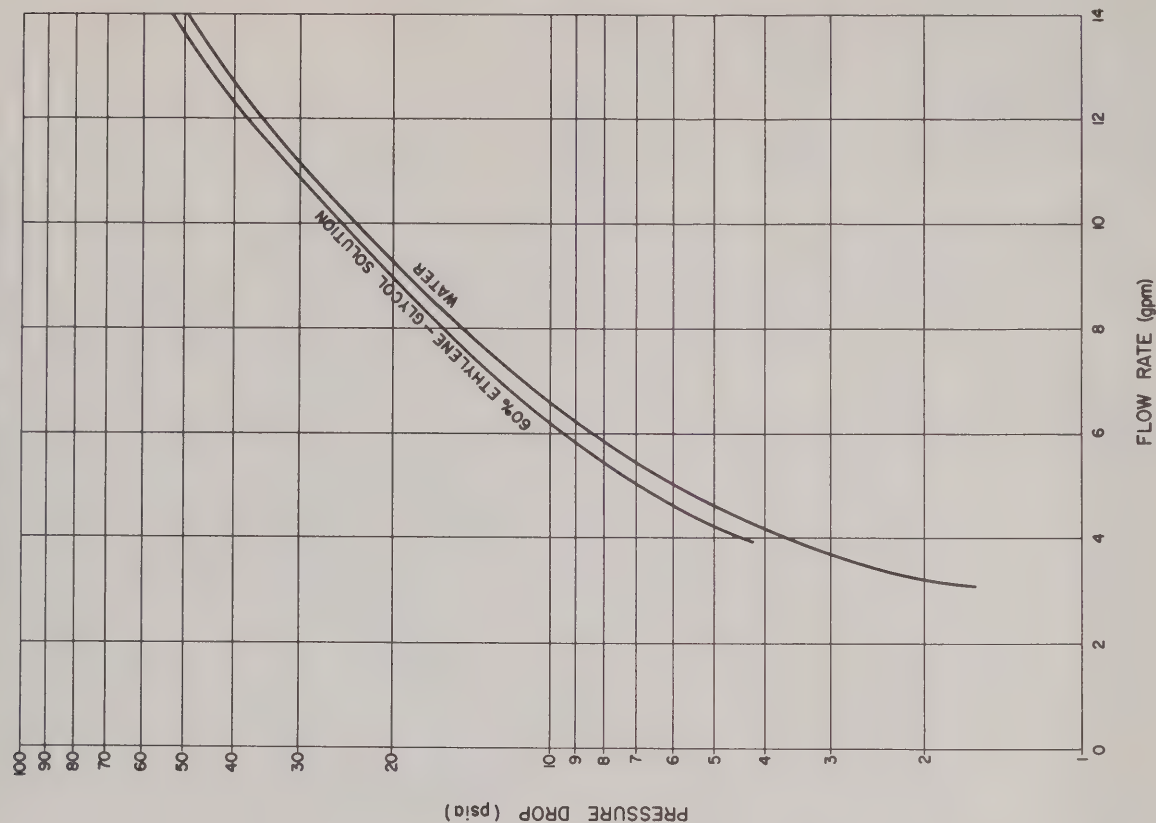
*At Sea Level with 20° C inlet air temperature.

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially.

EIMAC 4KM170,000LA

PRESSURE DROP VS COOLANT FLOW RATE

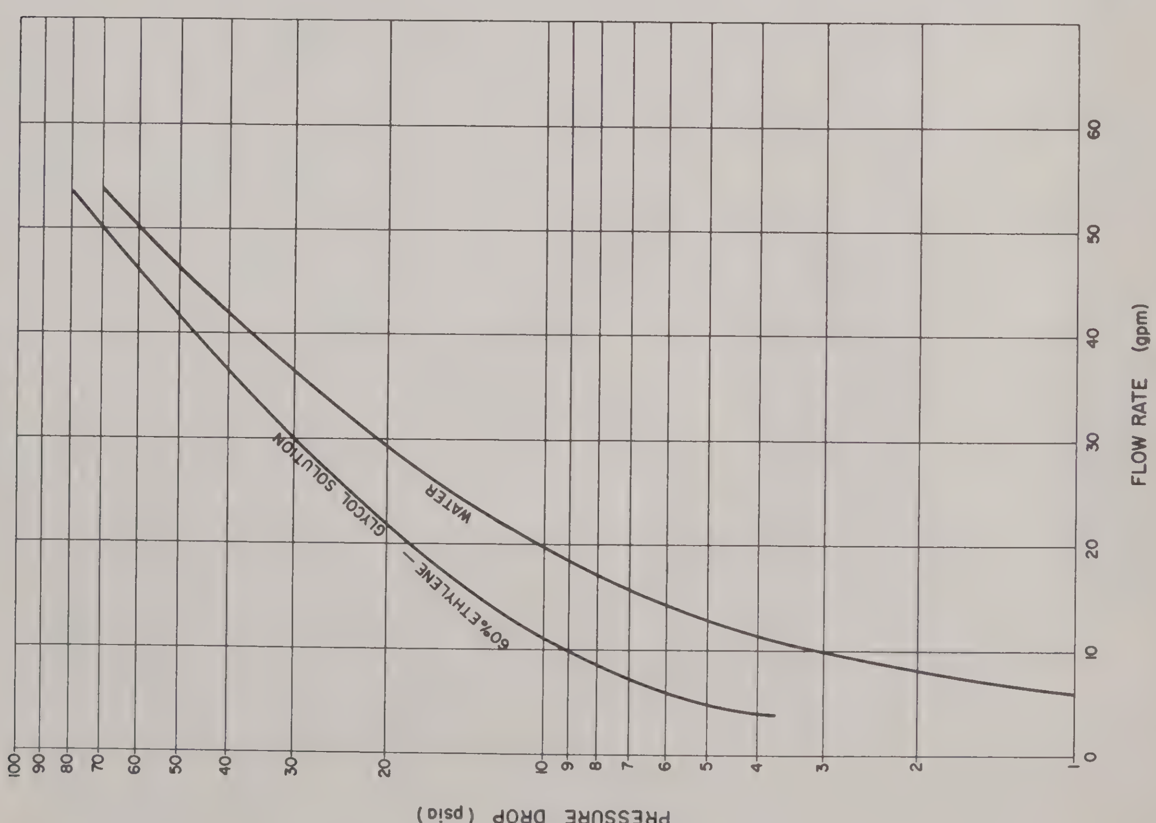
FIVE DRIFT TUBE JACKETS IN SERIES

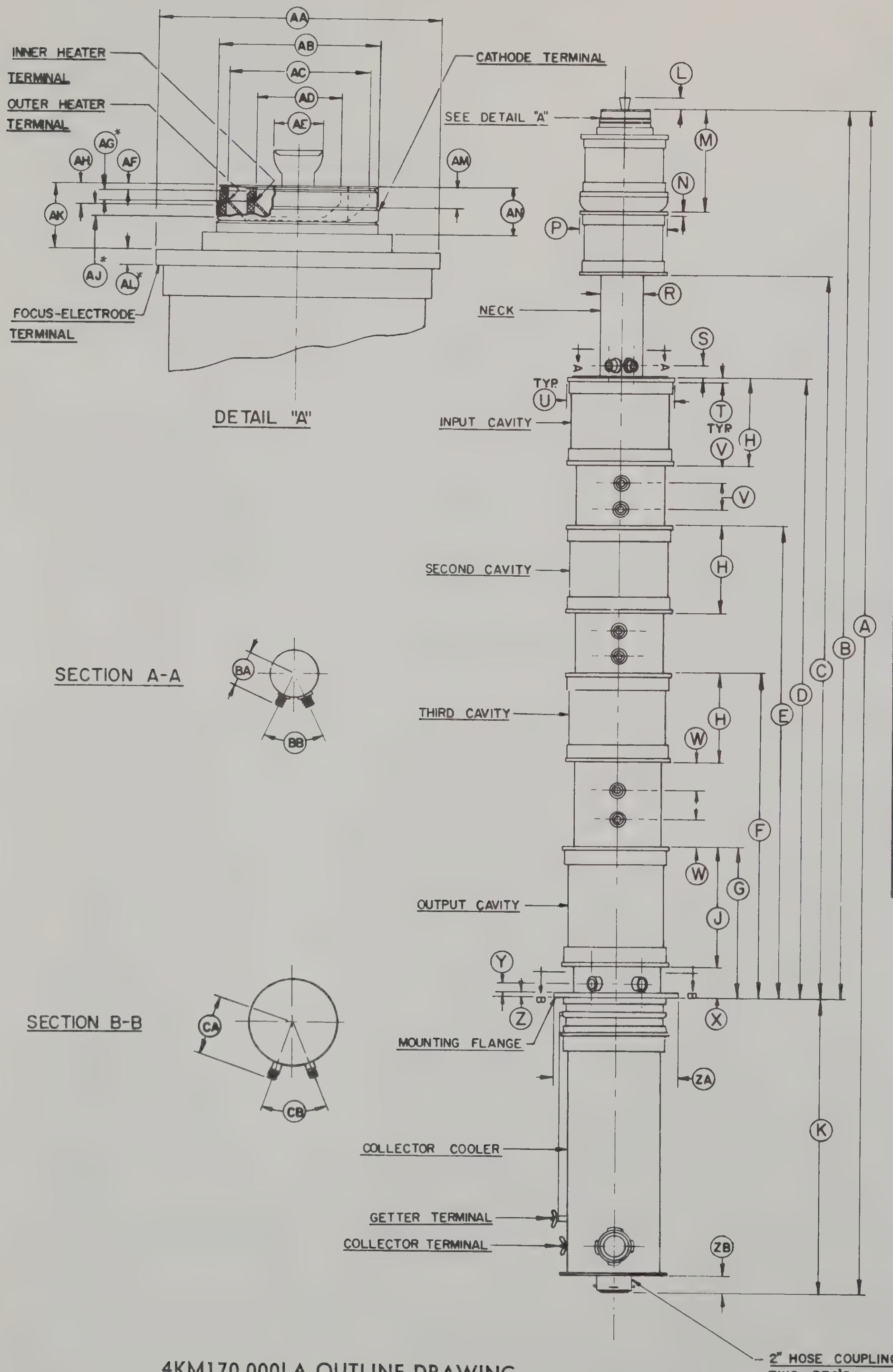


EIMAC 4KM170,000LA

PRESSURE DROP VS COOLANT FLOW RATE

ACROSS COLLECTOR





DIMENSIONAL DATA	
REF.	NOM.
A	86 1/2
B	67 1/4
C	54 7/8
D	44
E	35 3/4
F	24 1/2
G	11 1/4
H	6 3/4
J	8 3/4
K	19 5/8
L	1 3/4
M	7 9/16
N	23/64
P	6 5/8
R	3 1/8
S	7/8
T	3/8
U	8 1/8
V	1 9/32
W	2 1/4
X	2 1/4
Y	11/16
Z	5/8
ZA	9 1/2
ZB	1 1/8
AA	6 5/8
AB	3 3/4
AC	3 3/16
AD	1 15/16
AE	1 1/8
AF	5/16
AG	1/4
AH	3/4
AJ	1/8
AK	1 3/4
AL	3/8
AM	21/32
AN	1 5/16
BA	2 3/8
BB	50°
CA	4 1/2
CB	50°

4KM170,000LA OUTLINE DRAWING

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

4KMP10,000LF

PULSE AMPLIFIER
L-BAND KLYSTRON

The Eimac 4KMP10,000LF is a four-cavity, magnetically focused, pulse-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 570 and 630 megacycles and will deliver a minimum pulse output power of 200 kilowatts at two percent duty, or 400 kilowatts at one percent duty, with an average power of four kilowatts. Nominal power gain is 57 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. A modulating anode voltage of approximately one half the beam voltage is sufficient to realize full rated pulse output power.

The resonant cavities for the 4KMP10,000LF are completed through tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range, and allows external cavity loading for broad-band operation. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-127, for use with the 4KMP10,000LF, covers the frequency range of 570 to 630 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an Eimac SK-1200 socket.

CHARACTERISTICS

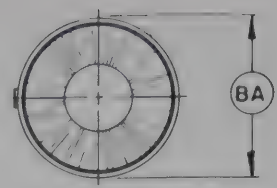
ELECTRICAL

Heater:	Voltage (±5%) - - -	11	volts
	Current (Normal) - - -	22	amperes
	Maximum Starting Current - -	50	amperes
Cathode:	Unipotential, Oxide Coated		
	Heating Time - - -	10	minutes
Getter (Operating):	Voltage (Nominal) -	5.1	volts
	Current - - -	36	amperes
	Maximum Starting Current	50	amperes
Power Gain:	(Narrow Band) - - -	57	decibels
Output Power:			
2% Duty	- - - - -	200	kilowatts
1% Duty	- - - - -	400	kilowatts
Average	- - - - -	4	kilowatts
Frequency Range	- - -	570 to 630	megacycles

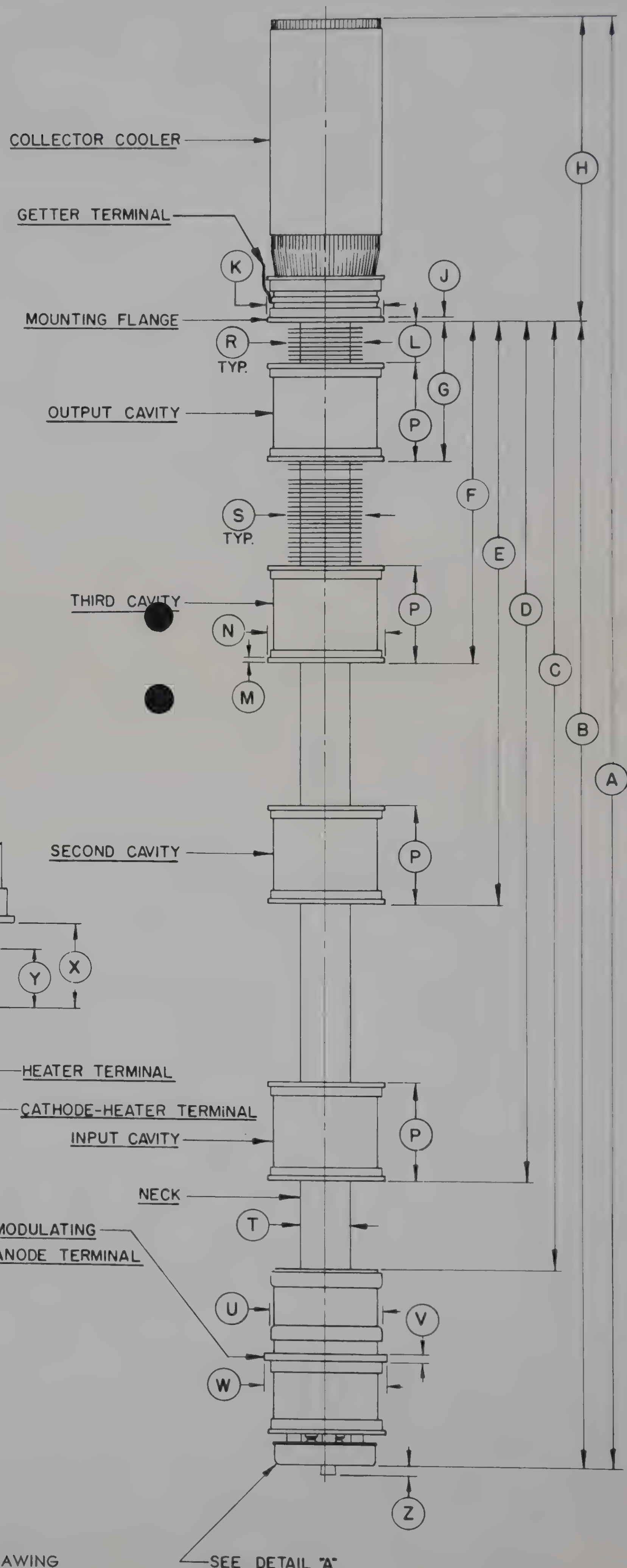
Capacitance between Modulating Anode and all other Tube Elements:

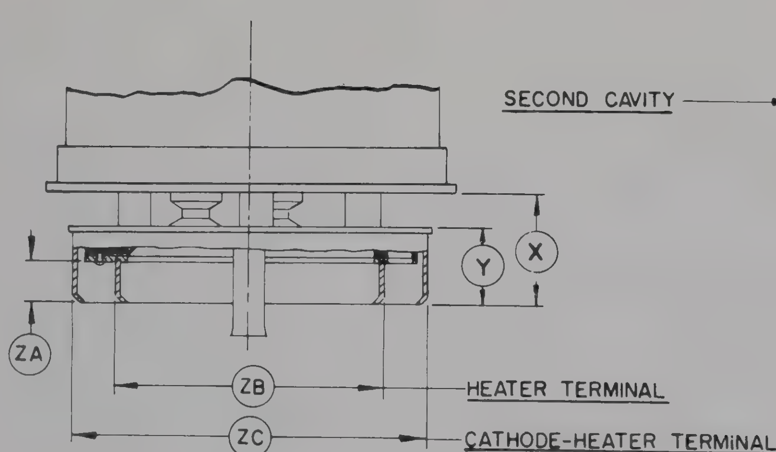
Maximum	- - - - -	60	micromicrofarads
Typical	- - - - -	37	micromicrofarads

DIMENSIONAL DATA	
REF.	NOM.
A	84
B	66 1/4
C	54 7/8
D	50 5/32
E	34 3/16
F	20 1/4
G	10 1/2
H	17 13/16
J	1/4
K	6 5/8
L	2 1/4
M	1/4
N	6 5/8
P	6 1/64
R	4 7/16
S	4
T	2 1/2
U	6 5/8
V	3/8
W	6 7/8
X	1 3/4
Y	1 9/32
Z	1
ZA	1/2
ZB	4 3/8
ZC	5 3/4
BA	6 11/32



COLLECTOR COOLER
END VIEW





DETAIL "A"

4KMP10,000LF OUTLINE DRAWING

4KMP10,000LF

MECHANICAL

Operating Position			Axis Vertical Cathode down (in oil)
R-F Input Coupling			Type N Coaxial Fitting
R-F Output Coupling			WR1500 Waveguide
Weight (Tube only)			140 pounds
Cooling: Forced Air and Oil			
Cathode (With SK-1200 socket) - oil			
		Flow Rate	Pressure Drop
Body		*100 cfm air	1 inch H_2O
Output Cavity		*50 cfm air	1 inch H_2O
Collector		*400 cfm air	2.5 inches H_2O

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS
(Eimac H-127 Klystron Amplifier Circuit Assembly)

	Min.	Max.	
Prefocus Coil: Voltage (dc)	0	40	volts
Current (dc)	0	2.5	amperes
Each of Five Body Coils:			
Voltage (dc)	0	40	volts
Current (dc)	0	12.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	70	KILOVOLTS
PEAK D-C BEAM CURRENT	22.5	AMPERES
PEAK MODULATING ANODE VOLTAGE	44	KILOVOLTS
AVERAGE D-C BODY CURRENT	15	MILLIAMPERES
COLLECTOR DISSIPATION	10	KILOWATTS
PULSE LENGTH	60	MICROSECONDS
SEAL TEMPERATURES	175	DEGREES C
A-C GETTER CURRENT	50	AMPERES

TYPICAL OPERATION, NARROW BAND PULSE AMPLIFIER

Frequency	600	megacycles
Peak Output Power	466	kilowatts
Average Output Power	4.66	kilowatts
Peak Driving Power	0.8	watts
Power Gain	57.4	decibels
D-C Beam Voltage	65	kilovolts
Average D-C Beam Current	165	milliamperes
Peak D-C Beam Current	16.5	amperes
Peak Modulating Anode Voltage	32	kilovolts
D-C Body Current (Average)	9.5	milliamperes
D-C Collector Current (Average)	156	milliamperes
Beam Input Efficiency (Average)	43.4	percent

MAGNETIC-COIL CURRENTS (H-127 Circuit Assembly)

Prefocus Coil	1.9	amperes
First Body Coil	6.3	amperes
Second Body Coil	7.5	amperes
Third Body Coil	7.5	amperes
Fourth Body Coil	8.5	amperes
Fifth Body Coil	8.5	amperes

*At Sea Level with 20° C inlet air temperature.

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially.

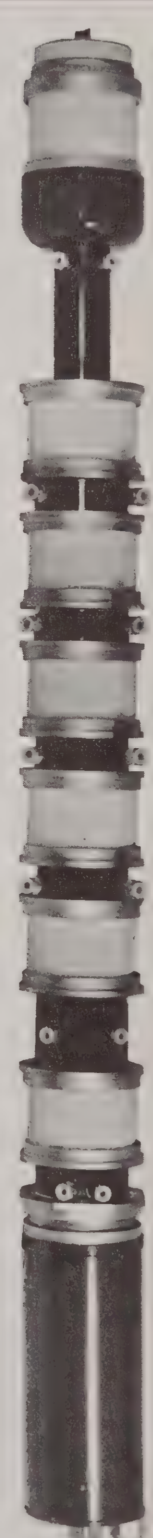
Printed in U.S.A. 585

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

6K50,000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 6K50,000LQ is a six-resonant-cavity, magnetically focused, cascade amplifier klystron designed primarily for CW high-power, broad-band communication service in the frequency range of 720 to 980 megacycles.

When tuned for narrow-band operation, this tube type will provide 10 kilowatts of CW r-f output power with a power gain of more than 50 db. When tuned for broad-band operation, this tube type will provide more than 6 kilowatts of CW r-f output power with a power gain of more than 30 db and bandwidths of 15 to 20 megacycles between the 3-db power points

The resonant cavities of the Eimac 6K50,000LQ have cylindrical ceramic windows and are completed by tuning boxes external to the tube. Klystron amplifier circuit assemblies designed for use with this tube provide the required external tuning boxes, magnetic focusing frame, and magnetic focusing coils. Such circuit assemblies also provide both input and output coaxial-type radio-frequency fittings. In addition, these circuit assemblies include an air-system socket which provides for cooling and making connections to the electron-gun portion of the tube.

CHARACTERISTICS

ELECTRICAL

Filament: Tungsten		
Voltage	8.0	volts
Current	40	amperes
Maximum Starting Current	80	amperes
Minimum Warm-Up Time	30	seconds
Cathode: Unipotential, Bombardment Heated		
Voltage	2280	volts
Current	0.7	ampere
Power	1596	watts
▶ Frequency Range	720 to 985	mc

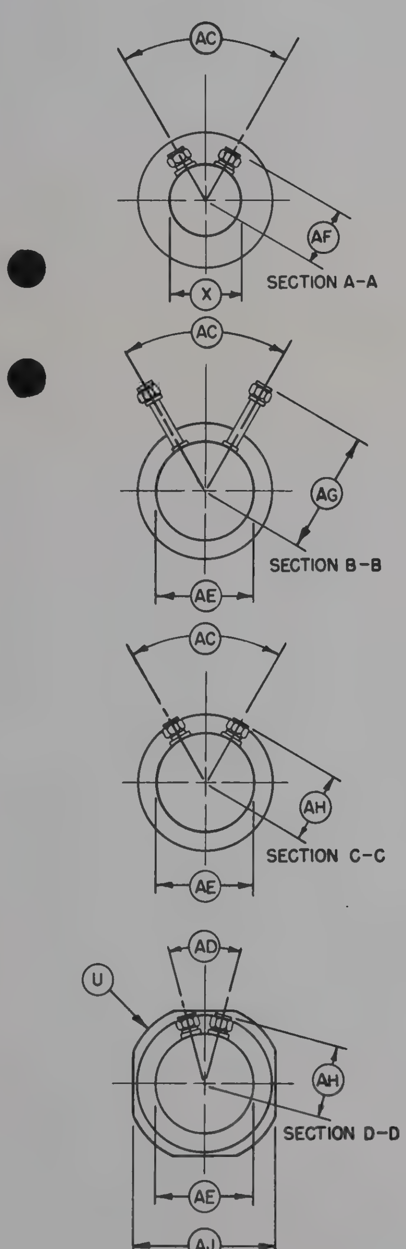
MECHANICAL

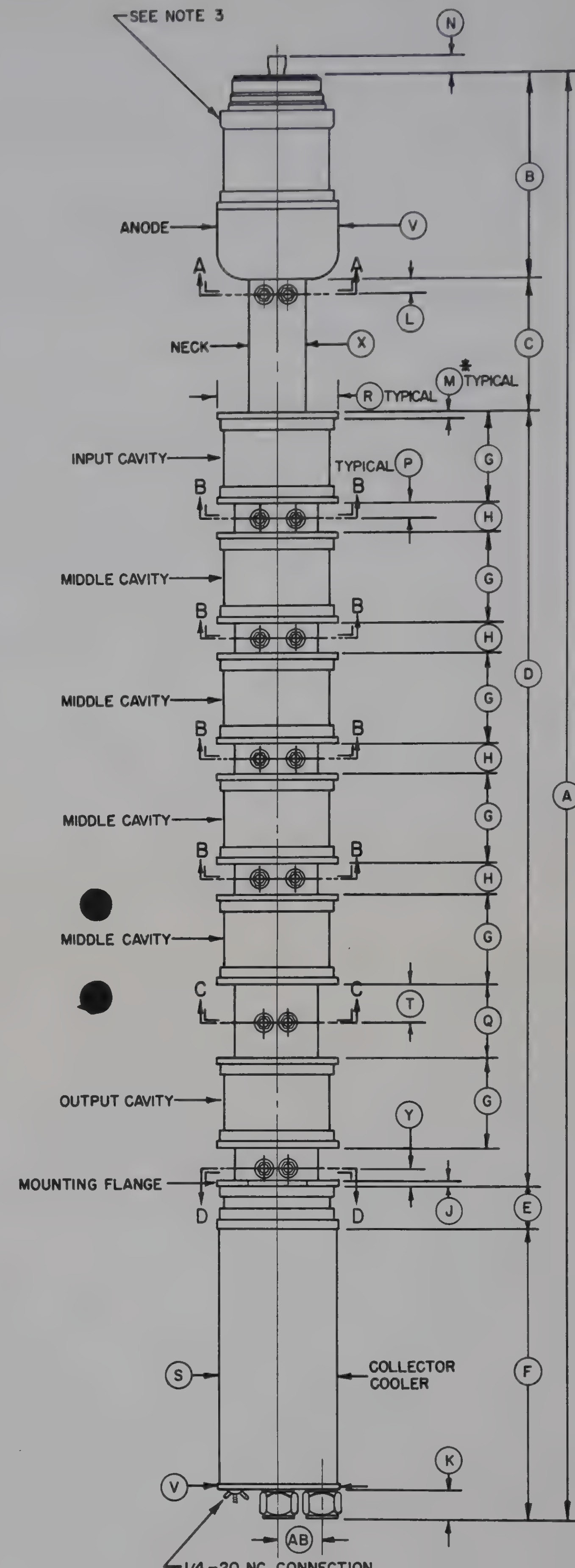
Operating Position	Vertical, cathode end up
Recommended Socket	Eimac SK-110
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3 1/8-inch coaxial line
Approximate Weights:	
Net	63 pounds
Shipping	390 pounds

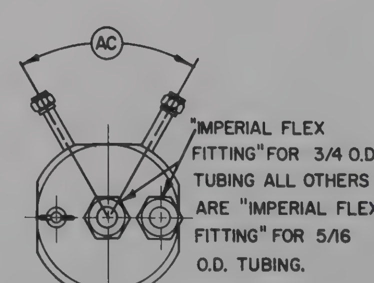
▶ Indicates change from sheet dated 2-10-58

Eimac 6K50,000LQ

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		54.750	55.500
B		7.437	7.687
C		4.968	5.031
D		29.875	30.125
E	1.625		
F		10.812	11.062
G		3.468	3.531
H		1.156	1.218
J	.250		
K	1.062		
L	.562		
M		.187	
N	.500		
P	.593		
Q		2.718	2.781
R		4.615 DIA.	4.635 DIA.
S	4.500 DIA.		
T	1.375		
U	5.125 DIA.		
V	4.625 DIA.		
X	2.125 DIA.		
Y	.687		
AB	1.625		
AC	60°		
AD	30°		
AE	3.500 DIA.		
AF	1.875		
AG	4.000		
AH	2.565		
AJ	4.625		







COLLECTOR END VIEW

NOTES:

1. * MINIMUM CONTACT SURFACES FOR ALL CAVITY PLATES.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. 2 OUTLINE, DRWG. NO. GUN NO. 2 -6001.

COOLING REQUIREMENTS

	Volume	Pressure Drop
Cathode (With Eimac SK-110)	52 cfm air	5 inches H_2O
Fifth Cavity (Broad-Band Applications Only)	50 cfm air	1.5 inches H_2O
Output Cavity	50 cfm air	1.5 inches H_2O
Drift-Tube Jackets (Series Connected)	1 gpm water	11 psi
Collector Assembly	25 gpm water	28 psi

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20 MAX. KILOVOLTS
D-C BEAM CURRENT	2.5 MAX. AMPERES
D-C BODY CURRENT (CONTINUOUS)	0.1 MAX. AMPERE
D-C BODY CURRENT (TUNING ONLY)	0.15 MAX. AMPERE
D-C FOCUS-ELECTRODE VOLTAGE	-500 MAX. VOLTS
BOMBARDED CATHODE:	
VOLTAGE	2400 MAX. VOLTS
CURRENT	0.75 MAX. AMPERE
POWER	1600 MAX. WATTS
COLLECTOR DISSIPATION	50 MAX. KILOWATTS

TYPICAL OPERATION

Frequency	880	880	megacycles
Output Power	6.4	9	kilowatts
Bandwidth (3-db power points)	20	15	megacycles
Driving Power	1.7	2.3	watts
Power Gain	35.6	35.9	db
D-C Beam Voltage	17	19.5	kilovolts
D-C Beam Current	1.88	2.30	amperes
Beam Input Power	31.96	44.85	kilowatts
Beam-Power Efficiency	20	20	percent
D-C Body Current	50	50	milliamperes
D-C Collector Current	1.83	2.25	amperes
D-C Focus-Electrode Voltage	-175	-200	volts
Filament Voltage	8	8	volts
Filament Current	40	40	amperes
Bombarded Cathode:			
Voltage	2280	2280	volts
Current	0.7	0.7	ampere
Power	1596	1596	watts
Collector Dissipation	24.71	34.88	kilowatts

APPLICATION

For additional information or information regarding a specific application, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially and without charge.

klystrons

Look in the general section for---

- Your nearest distributor of modern, fully guaranteed Eimac electron tubes and electron tube accessories.
- Your nearest Eimac Field Engineer, who stands ready to give you immediate engineering assistance, information on deliveries and prices, or provide other information not found in the catalog.
- Eimac tube type numbering system.
- Tube Replacement Chart.
- Prices on Eimac products.

IMPORTANT EIMAC "EXTRAS"

Application Engineering. The Eimac Application Engineering Department is available at all times for consultation. New tube operating techniques are continually being explored, tested and proved by Eimac engineers, whose combined knowledge and experience are at your service. Additional contributions by this Eimac department are its Application Bulletins, a service which you receive without obligation.

Field Engineering. Serving as an extension of the Application Engineering Department outside the Eimac plant, Eimac Field Engineers cover the United States, operating out of offices in major cities. They will help you personally with experimental work, problems of technique, etc. Engineers from Eitel-McCullough, Inc. are available, too, for field consultation throughout the country. As Eimac tubes are world renowned, the same services extend to various countries overseas through the Eimac Export Department.

klystrons

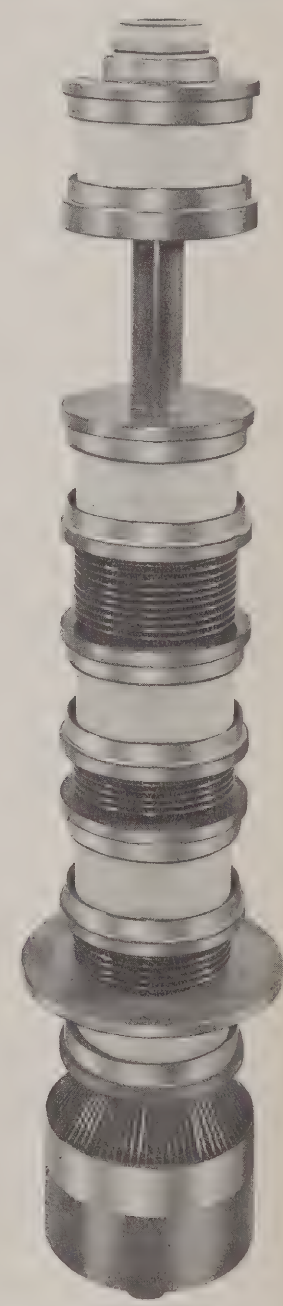
klystrons

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

3K2500LX

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 3K2500LX is a ceramic and metal, three cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 980 and 1200 megacycles. It will deliver a minimum CW output power of one kilowatt with a power gain of more than 25 db.

The resonant cavities of the 3K2500LX have cylindrical ceramic windows and are completed by tuning boxes external to the tube. This design permits a wide tuning range, and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-114) has been designed for use with this tube. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated	
	Minimum Heating Time	5 minutes
Heater:	Voltage	7.5 volts
	Current	5.8 amperes
	Maximum Starting Current	15 amperes
Power Gain		25 db
Output Power		1000 watts
Frequency Range		980 to 1200 mc

MECHANICAL

Operating Position*		Axis vertical
R-F Coupling:		
	Input	Type "N" coaxial fitting
	Output	1 5/8-inch 50-ohm air line
Cooling (See Application)		Forced air
Net Weight		22 pounds
Shipping Weight (Approximate)		80 pounds
Maximum Over-All Dimensions:		
	Length	25 7/8 inches
	Diameter	5 1/8 inches

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-114 Coils)

Prefocus-Coil Voltage	0 to 35	volts
Prefocus-Coil Current	0 to 1.0	ampere
Body-Coil Voltage	0 to 165	volts
Body-Coil Current	0 to 2.5	amperes

*Cathode end up when installed in the Eimac H-114 circuit assembly.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	7000	MAX. VOLTS
D-C BEAM CURRENT	600	MAX. MA
D-C BODY CURRENT (CONTINUOUS)	60	MAX. MA
D-C BODY CURRENT (TUNING ONLY)	90	MAX. MA
D-C FOCUS-ELECTRODE VOLTAGE	-100	MAX. VOLTS
COLLECTOR DISSIPATION	2500	MAX. WATTS

TYPICAL OPERATION

NARROW-BAND CW AMPLIFIER (In H-114 Circuit Assembly)

Frequency	1000	1000	megacycles
Output Power	830	1320	watts
Driving Power	2	2	watts
Power Gain	26.1	28.2	db
D-C Beam Voltage	6000	7000	volts
D-C Beam Current	350	455	milliamperes
Beam Input Power	2100	3180	watts
Beam Power Efficiency	39.5	41.4	percent
D-C Body Current	40	30	milliamperes
D-C Collector Current	310	425	milliamperes
Collector Dissipation*	1030	1650	watts
Focus-Electrode Voltage	-100	-100	volts
Heater Voltage	7.5	7.5	volts
Heater Current	5.8	5.8	amperes
Magnetic-Coil Currents:*			
Prefocus	0.5	0.5	ampere
Body	2.0	2.0	amperes

*Approximate values.

APPLICATION

Cooling--When the 3K2500LX is operated at sea level, with an ambient air temperature of less than 30° C (86°F), the cathode will normally require only convection air cooling. At higher altitudes or temperatures, forced-air cooling must be used to maintain the temperature of the metal button at the cathode end of the tube below 150°C.

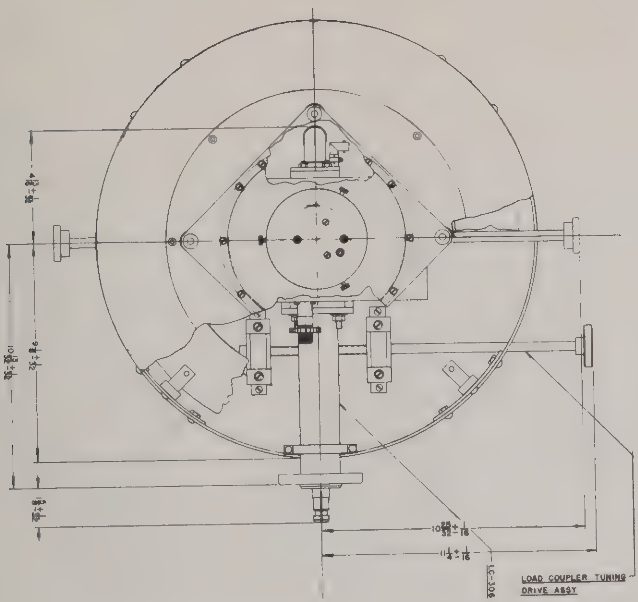
With a maximum ambient temperature of 25° C (77° F) and at sea level, the air-flow rates tabulated below are sufficient for operation at maximum ratings.

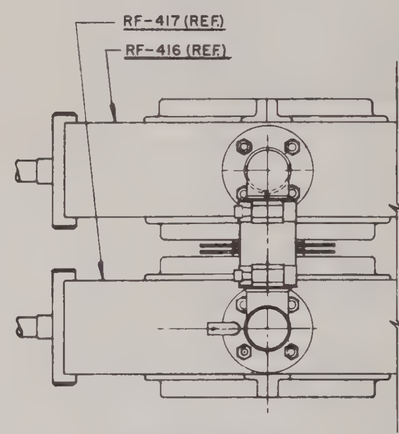
Output and Middle Cavities (Combined)	50 cfm
Collector	150 cfm

At higher temperatures or altitudes, the air-flow rate must be increased to obtain equivalent cooling.

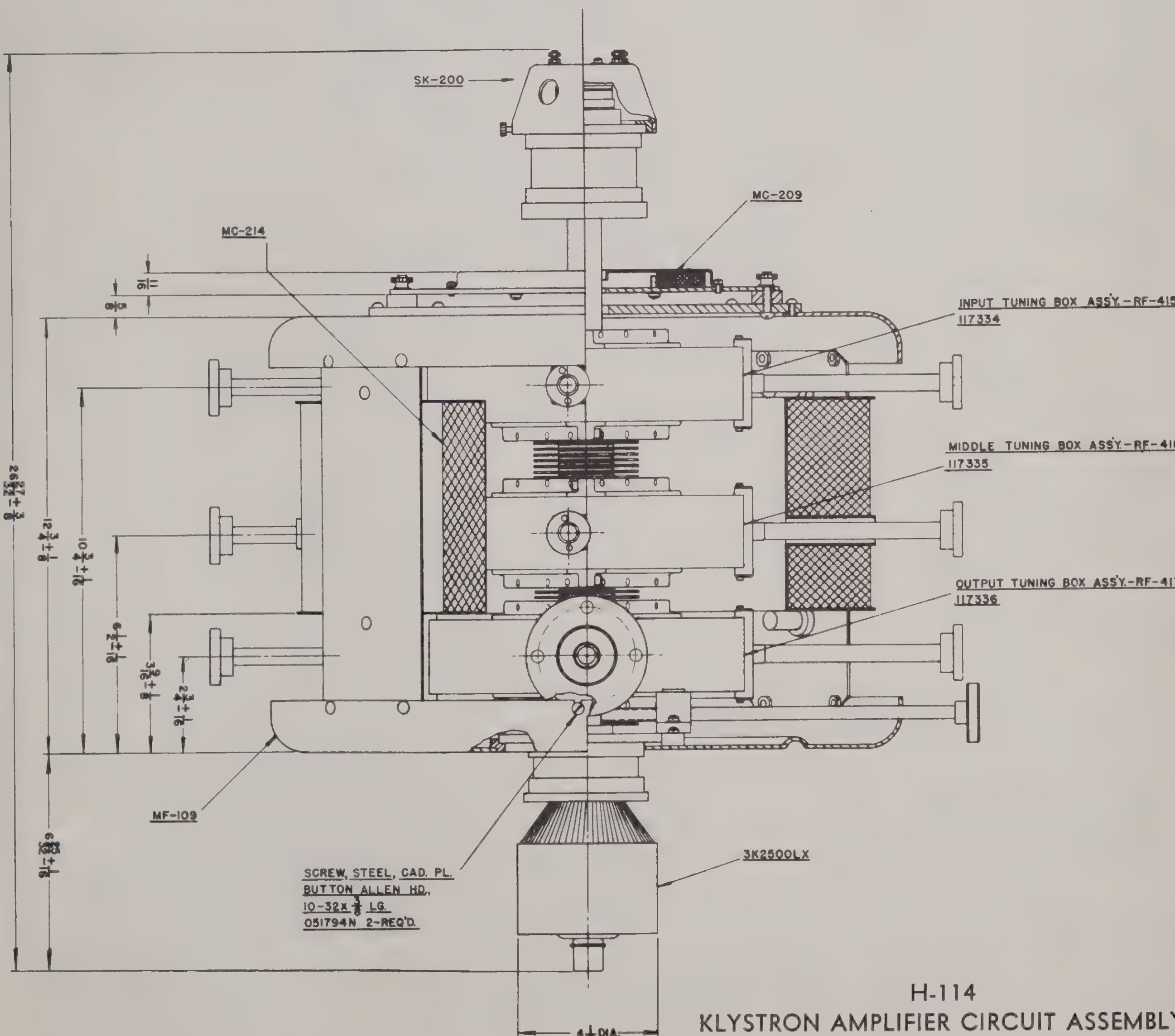
Body cooling is normally provided by the escaping air from the tuning boxes. However, if the ambient air temperature exceeds 30° C, forced air will also be required on the body cooling fins.

Special Applications--If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California.



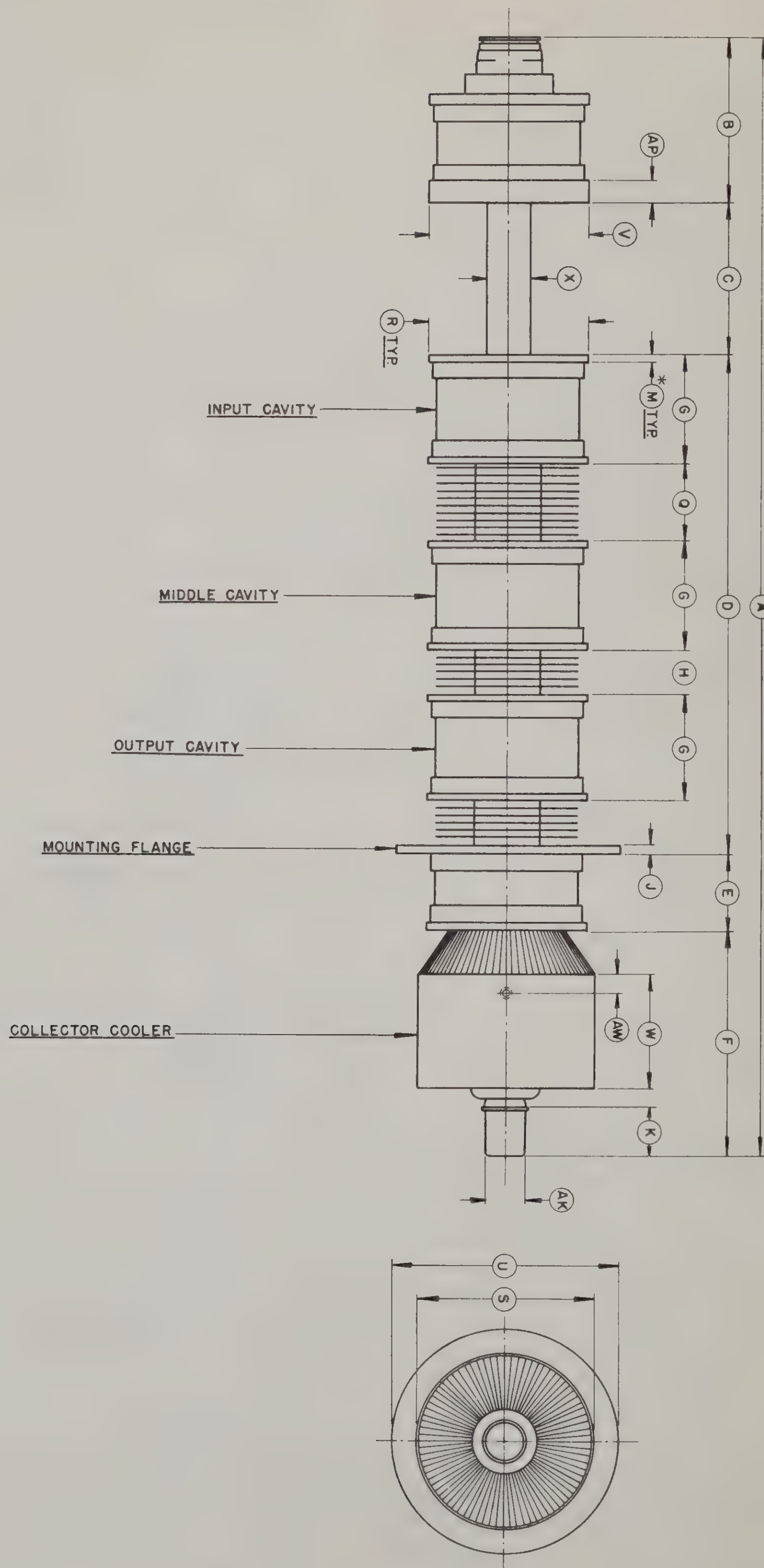


DETAIL SHOWING COOLING TUBE ASSY.



H-114
KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		25.438	26.188
B		3.730	3.980
C		3.406	3.470
D		11.107	11.357
E	1.976		
F		5.187	5.437
G		2.464	2.528
H		.971	1.033
J		.220	.240
K		1.115	1.135
M		.187	
Q		1.710	1.774
R		3.615 DIA.	3.635 DIA.
S		3.985 DIA.	4.015 DIA.
U		5.118 DIA.	5.148 DIA.
V		3.615 DIA.	3.635 DIA.
W	2.625		
X		.992 DIA.	1.008 DIA.
AK		.865 DIA.	.885 DIA.
AP		.490	.510
AW		.428	.448



NOTES:

1. *MINIMUM CONTACT SURFACES.
2. DIMENSIONS IN INCHES

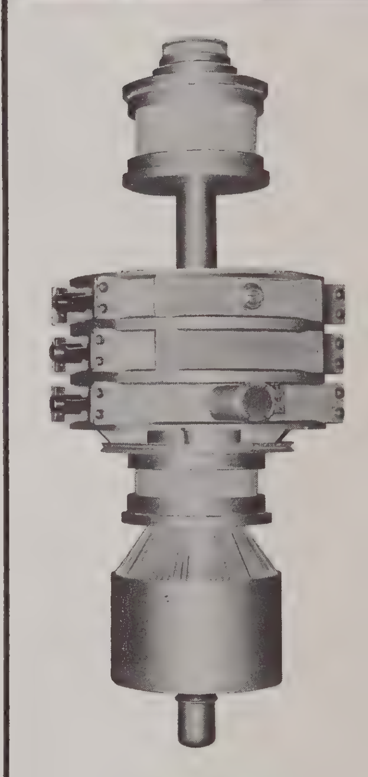
3K2500LX
OUTLINE DRAWING

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

3K2500SG

POWER-AMPLIFIER S-BAND KLYSTRON



The Eimac 3K2500SG is a ceramic and metal, three-cavity, magnetically focused, power-amplifier klystron designed primarily for communication service in the frequency range of 1700 to 2400 megacycles. It will deliver a minimum CW output power of one kilowatt throughout this range with a power gain of 25 db.

The resonant cavities of the 3K2500SG are an integral part of the tube structure and are completed and tuned outside the vacuum envelope. This design allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-113) has been designed for use with this tube type. This assembly includes an electromagnetic frame and coils, an adjustable load coupler, an air manifold, and an Eimac SK-200 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	7.5 volts
Current	5.5 amperes
Output Power	1000 watts
Power Gain	25 db
Frequency Range	1700 to 2400 mc

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-113 Circuit Assembly)

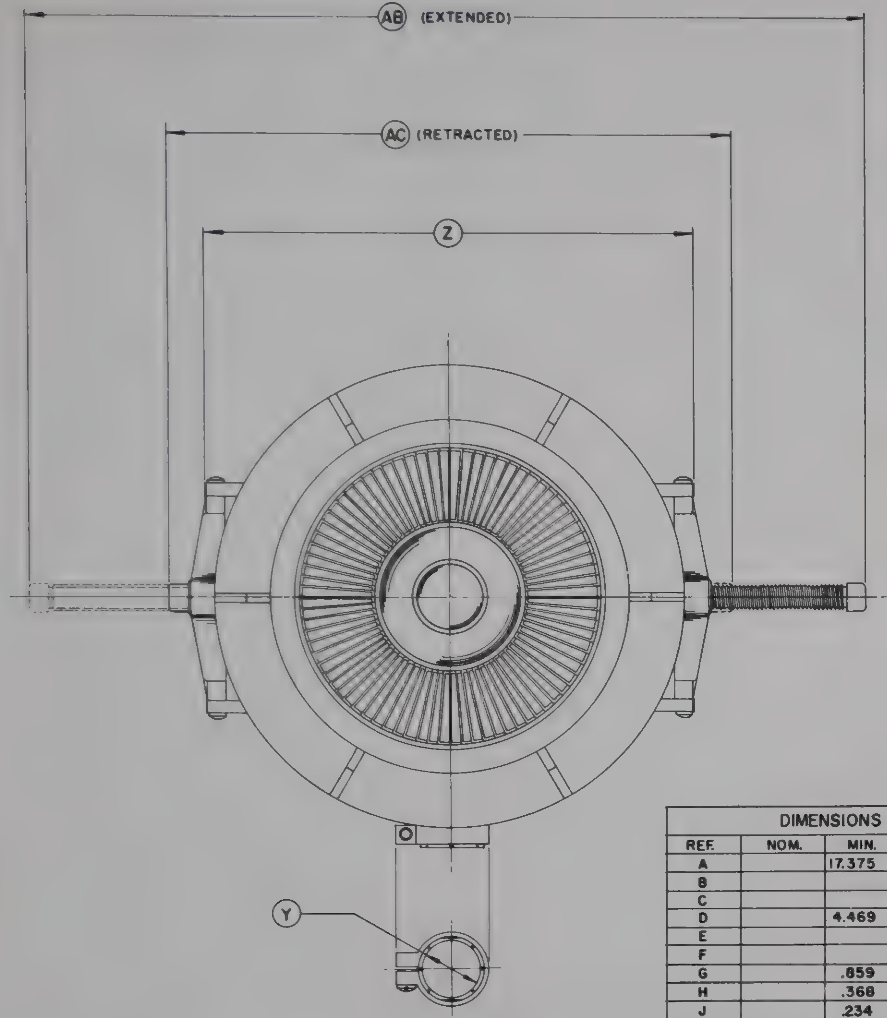
Prefocus-Coil Voltage	0 to 25 volts
Prefocus-Coil Current	0 to 1 ampere
Body-Coil Voltage	50 to 100 volts
Body-Coil Current	2 to 4 amperes
Collector-Coil Voltage	0 to 10 volts
Collector-Coil Current	0 to 3 amperes

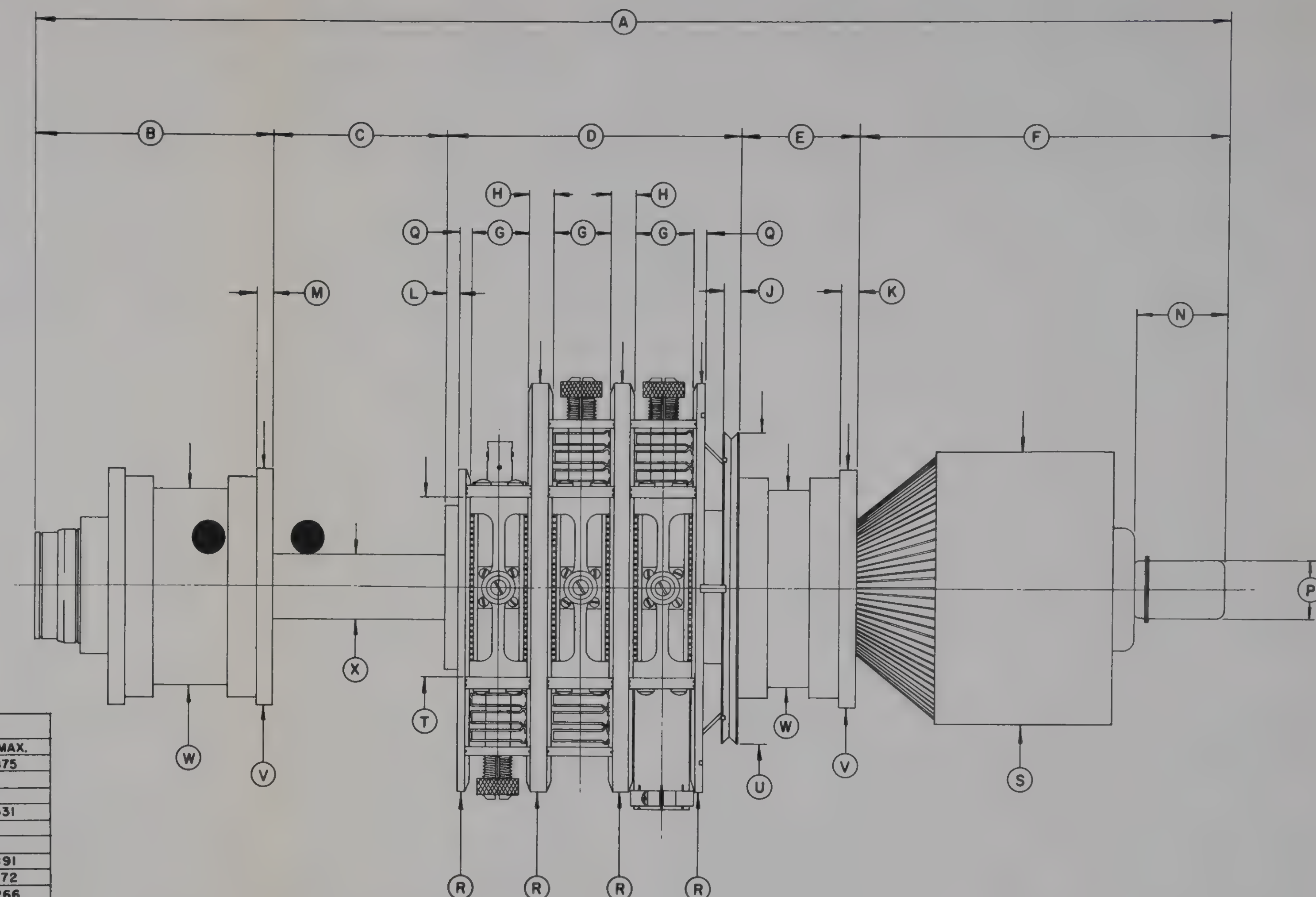
MECHANICAL

Operating Position*	Axis vertical
Recommended Socket	Eimac SK-200
R-F Coupling:	
Input	BNC
Output (From load coupler)	RETMA 1 5/8-inch 50-ohm air line
Cooling (See back page)	Forced air
Net Weights:	
Tube Only	28 pounds
Tube and Circuit Assembly	143 pounds
Shipping Weights: (Approximate)	
Tube Only	130 pounds
Circuit Assembly Only	145 pounds

* Cathode end up when installed in Eimac H-113 Circuit Assembly.

3K2500SG





DIMENSIONS			
REF.	NOM.	MIN.	MAX.
A		17.375	17.875
B			
C			
D		4.469	4.531
E			
F			
G		.859	.891
H		.368	.372
J		.234	.266
K		.234	.266
L			
M		.245	.255
N			
P		.859 DIA.	.891 DIA.
Q		.173	.177
R		6.234 DIA.	6.266 DIA.
S		4.109 DIA.	4.141 DIA.
T		2.745	2.755
U		4.734 DIA.	4.766 DIA.
V		3.609 DIA.	3.641 DIA.
W		2.998 DIA.	3.002 DIA.
X		.969 DIA.	1.000 DIA.
Y		.745 I.D.	.755 I.D.
Z		6.495	6.505
AB	10 9/16		
AC	7 9/16		

3K2500SG

OUTLINE DRAWING

(TENTATIVE)

COOLING

The cathode of the 3K2500SG requires no forced-air cooling if operated under conditions where the ambient air temperature is 30° C or less. In installations where the ambient air temperature exceeds 30° C, enough air must be used to maintain the temperature of the metal button at the cathode end of the tube below 150° C. A short piece of 3/8-inch tubing, bleeding air from the drift-tube air-supply inlet tube and directed at the cathode button, will ordinarily supply sufficient cooling.

With an ambient air temperature of 30° C and at sea level, minimum air-flow requirements and approximate pressure drops for the drift tubes and collector cooler are:

	Flow Rate	Pressure Drop
Drift Tubes	100 cfm	2.3 inches H_2O
Collector	100 cfm	1.5 inches H_2O

NOTE: Since some of the air used to cool the drift tubes is channeled through the r-f cavities by means of screened doors, the air supply must be well filtered to avoid the deposit of dirt and metal particles within the cavities.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	7000 MAX. VOLTS
D-C BEAM CURRENT	600 MAX. MA
D-C BODY CURRENT (CONTINUOUS)	60 MAX. MA
D-C BODY CURRENT (TUNING ONLY)	90 MAX. MA
FOCUS-ELECTRODE VOLTAGE	-100 MAX. VOLTS
COLLECTOR DISSIPATION	2500 MAX. WATTS

TYPICAL OPERATION In Eimac H-113 Circuit Assembly

Frequency	1700	2400	megacycles
Output Power	1.35	1.3	kilowatts
Driving Power	4	4	watts
Power Gain	25	25	db
D-C Beam Voltage	7	7	kilovolts
D-C Beam Current	570	570	milliamperes
Beam Input Power	4	4	kilowatts
Beam Power Efficiency	33.8	30.7	percent
D-C Body Current	30	50	milliamperes
D-C Collector Current	540	520	milliamperes
Focus-Electrode Voltage	0	0	volts
Heater Voltage	7.5	7.5	volts
Heater Current	5.5	5.5	amperes
Prefocus-Coil Voltage	14	14	volts
Prefocus-Coil Current	0.4	0.4	ampere
Body-Coil Voltage	77	77	volts
Body-Coil Current	3.5	3.5	amperes
Collector-Coil Voltage	6	6	volts
Collector-Coil Current	1.5	1.5	amperes

APPLICATION

If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California.

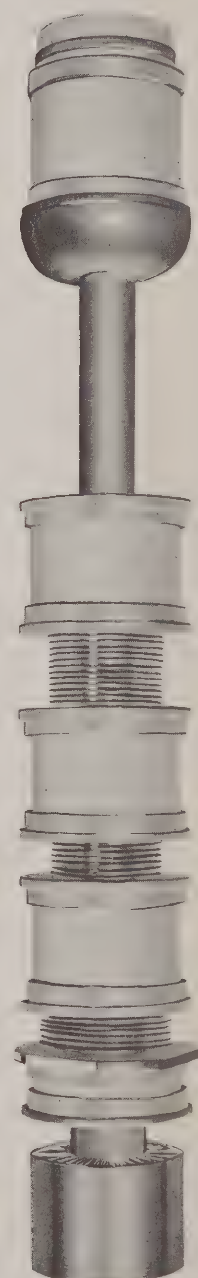
Printed in U.S.A. 45270

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

3K3000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 3K3000LQ is a ceramic and metal, three-cavity magnetically focused, power-amplifier klystron designed for use at frequencies between 610 and 985 megacycles. It will deliver a minimum CW output power of two kilowatts with a power gain of more than 25 db.

The resonant cavities for the 3K3000LQ are completed through the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-102) has been designed for use with this tube and covers the frequency range of 720 to 985 megacycles. Other frequency ranges can be provided if required. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated	
	Minimum Heating Time	5 minutes
Heater:	Voltage	5.0 volts
	Current	31 amperes
	Maximum Starting Current	60 amperes
Power Gain		25 db
Output Power		2000 watts
Frequency Range (In H-102 Assembly)		720 to 985 mc

MECHANICAL

Operating Position*		Axis vertical
R-F Coupling:		
	Input	Type "N" coaxial fitting
	Output	1 5/8-inch 50-ohm air line
Net Weight		32 pounds
Shipping Weight (Approximate)		115 pounds
Maximum Over-All Dimensions:		
	Length	34 1/8 inches
	Diameter	5 1/8 inches

*Cathode end up when installed in H-102 circuit assembly.

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-102 Coils)

Prefocus-Coil Voltage		0 to 50 volts
Prefocus-Coil Current		0 to 1.5 amperes
Each of Two Body Coils:**		
	Voltage	0 to 150 volts
	Current	0 to 2.5 amperes

**These coils may be operated series connected with a slight decrease in beam efficiency.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	9000	MAX. VOLTS
D-C BEAM CURRENT	750	MAX. MA
D-C BODY CURRENT (CONTINUOUS)	75	MAX. MA
D-C BODY CURRENT (TUNING ONLY)	100	MAX. MA
D-C FOCUS-ELECTRODE VOLTAGE	-500	MAX. VOLTS
COLLECTION DISSIPATION	3000	MAX. WATTS

TYPICAL OPERATION

NARROW-BAND CW AMPLIFIER (In H-102 Circuit Assembly)

Frequency	850	850	megacycles
Output Power	1300	2790	watts
Driving Power	4	10	watts
Power Gain	25.1	24.4	db
D-C Beam Voltage	7000	9000	volts
D-C Beam Current	375	580	milliamperes
Beam Input Power	2625	5220	watts
Beam Power Efficiency	49.5	53.5	percent
D-C Body Current	30	30	milliamperes
D-C Collector Current	345	550	milliamperes
Collector Dissipation*	1535	2160	watts
Focus-Electrode Voltage	-200	-200	volts
Filament Voltage	5.0	5.0	volts
Filament Current	31	31	amperes
Magnetic-Coil Currents:*			
Prefocus	0.48	0.5	ampere
First Body	2.3	2.3	amperes
Second Body	1.6	2.15	amperes

*Approximate values.

APPLICATION

Cooling--The 3K3000LQ is cooled by forced air. At sea level and with an inlet air temperature of 20° C (68° F), the flow rates tabulated below are sufficient for operation at maximum ratings. Corresponding pressure drops, in inches of water column, are also listed to allow the effective measurement of air flow in the field without elaborate test equipment.

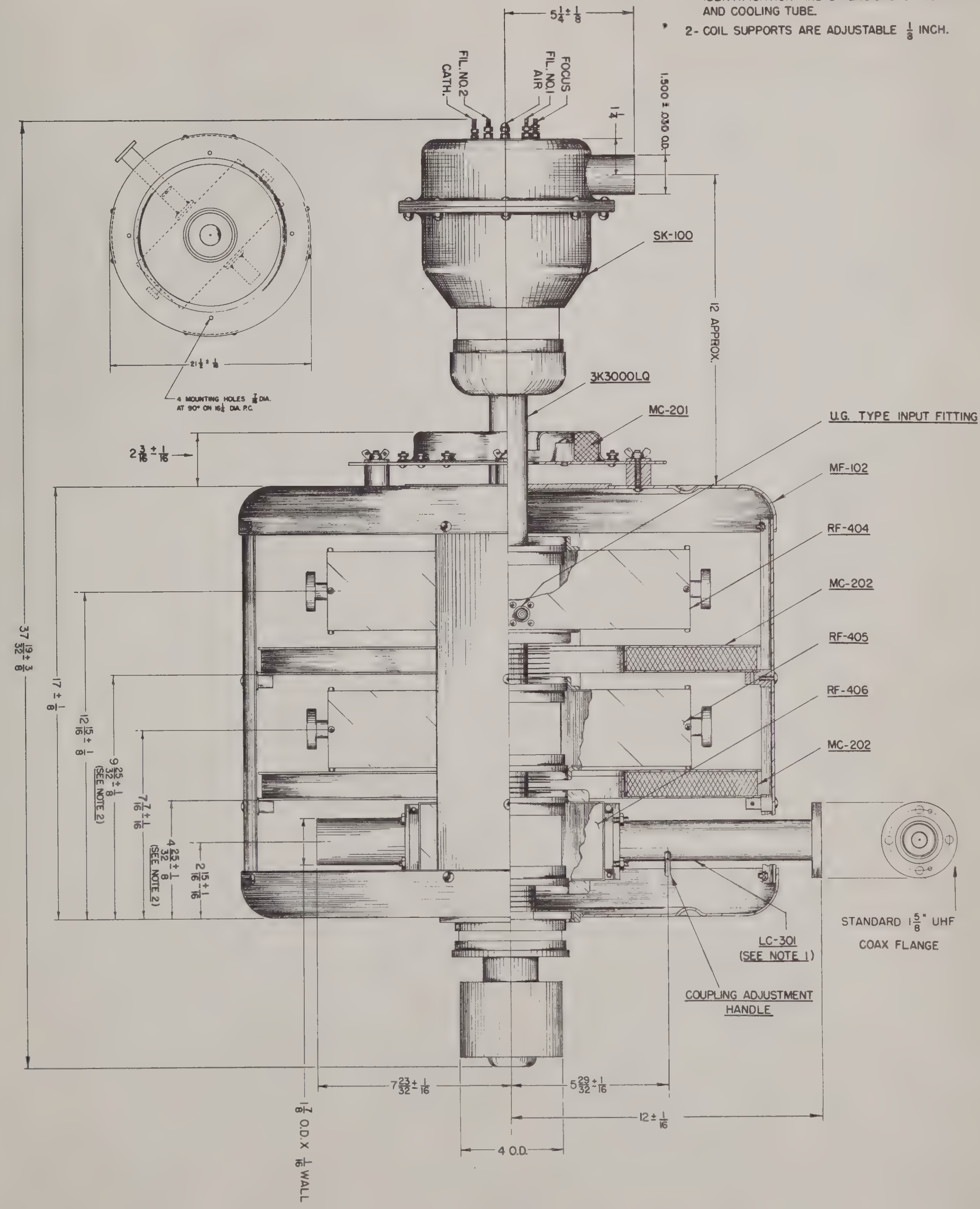
Cathode (With SK-100 Socket)	5 cfm	0.4 inch H^2O
Output Cavity	50 cfm	1.0 inch H^2O
Collector	150 cfm	1.6 inches H^2O

Operation at higher altitudes or with higher inlet air temperatures requires increased volumes of air flow to obtain equivalent cooling.

Since the collector dissipation rating of the 3K3000LQ may be exceeded in the event of a loss of driving power, the collector should be fitted with a thermal overload for maximum protection. This device should be set to operate at 175° C and installed in the beam-voltage supply circuit. The sensing element for this overload should be located on the input section of the collector body at the point indicated on the outline drawing.

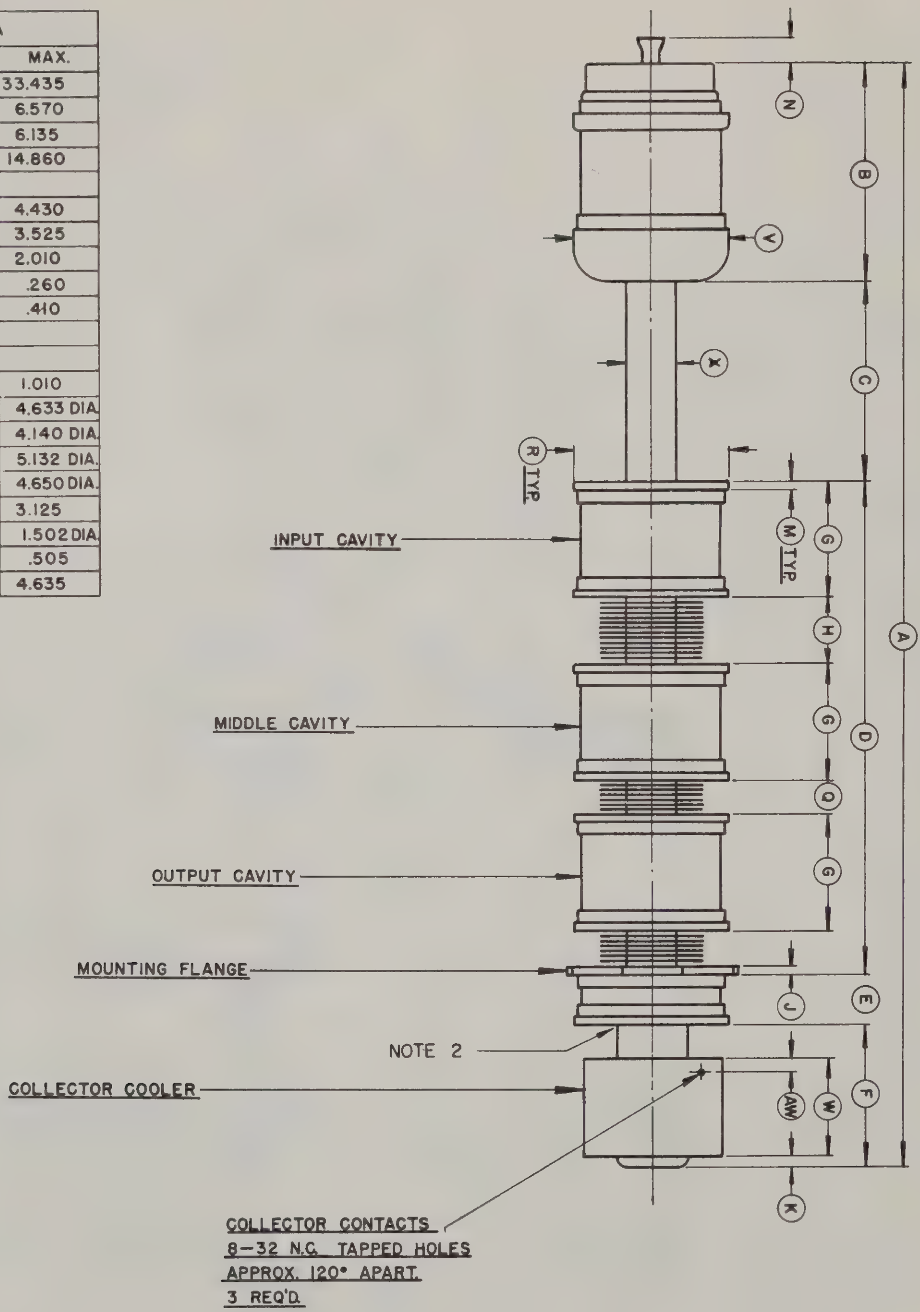
Special Applications--If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California.

NOTES:
1- THIS BOX IS SHOWN ROTATED 90° FOR PARTS IDENTIFICATION AND DIMENSIONS OF COUPLER AND COOLING TUBE.
2- COIL SUPPORTS ARE ADJUSTABLE $\frac{1}{8}$ INCH.



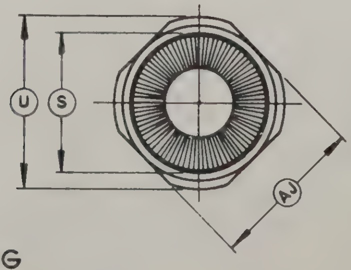
H-102
KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

DIMENSION DATA			
REF.	NOM	MIN.	MAX.
A		33.120	33.435
B		6.495	6.570
C		5.995	6.135
D		14.810	14.860
E	1.510		
F		4.360	4.430
G		3.495	3.525
H		1.985	2.010
J		.235	.260
K		.375	.410
M		.187	
N	.750		
Q		.980	1.010
R		4.618 DIA.	4.633 DIA.
S		4.125 DIA.	4.140 DIA.
U		5.118 DIA.	5.132 DIA.
V		4.615 DIA.	4.650 DIA.
W		2.950	3.125
X		1.490 DIA.	1.502 DIA.
AW		.405	.505
AJ		4.618	4.635



NOTES:

1. DIMENSIONS IN INCHES
2. LOCATE THERMAL-OVERLOAD SENSING ELEMENT HERE.



3K3000LQ
OUTLINE DRAWING

EITEL-McCULLOUGH, INC.

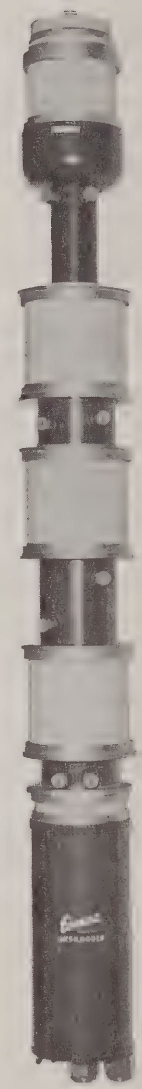
3K50,000LA
3K50,000LF
3K50,000LQ

POWER-AMPLIFIER L-BAND KLYSTRONS

The Eimac 3K50,000LA, 3K50,000LF and 3K50,000LQ are ceramic and metal three-cavity, magnetically focused, power-amplifier klystrons. Although intended primarily for UHF television broadcast service, these klystrons cover the frequency range of 365 to 985 megacycles when used with appropriate Eimac Klystron Amplifier Circuit Assemblies. Circuit assemblies include the necessary magnetic frame and coils, external tuning boxes, adjustable load coupler, and SK-110 Air-System Socket.

Each klystron type, when tuned for narrow-band CW operation, will deliver a minimum output power of 10 kilowatts with a power gain of 25 db. In television visual service, each klystron type will provide more than 12 kilowatts of peak synchronizing output power with a power gain of 20 db.

Resonant cavities for these UHF klystrons are completed through the cylindrical ceramics of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows repeated tuning cycling without damage to vacuum seals.



3K50,000LF KLYSTRON

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Pure Tungsten		
Voltage	8.0	volts
Current	40	amperes
Maximum Starting Current	80	amperes
Cathode: Unipotential, Bombardment Heated		
Voltage	2100	volts
Current	0.66	ampere
Power	1400	watts
Power Gain: Narrow-Band CW or FM	25	db
Television Visual Service	20	db
Output Power:		
Narrow-Band CW or FM	10,000	watts
Television Visual (Peak Synchronizing Level)	12,000	watts

Frequency Range Using Standard Eimac Circuit Assemblies*

Klystron Type	Circuit Assembly	Frequency Range	
3K50,000LA	H-108	400 to 600	mc
3K50,000LF	H-109A	570 to 660	mc
3K50,000LF	....	650 to 720	mc
3K50,000LQ	H-111	720 to 985	mc

*Eimac circuit assemblies for these klystrons covering other frequency ranges between the limits of 365 and 985 megacycles may be obtained on special order.

MECHANICAL

Operating Position	Axis vertical*			
Cooling (See "Application")	Water and forced air			
R-F Input Coupling	Type "N" coaxial fitting			
R-F Output Coupling	Standard 3⅛-inch 50-ohm air line			
Maximum Over-All Dimensions: Klystron Type	"A"	"F"	"Q"	
Length	51¼	49¾	39⅞	inches
Diameter	5⅛	5⅛	5⅛	inches
Net Weight	53	51	48	pounds
Shipping Weight (Approximate)	150	140	130	pounds

*Cathode end up when installed in standard Eimac circuit assemblies.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20	MAX. KILOVOLTS
D-C BEAM CURRENT	2.5	MAX. AMPERES
D-C BODY CURRENT (CONTINUOUS)	150	MAX. MA
D-C BODY CURRENT (TUNING ONLY)	250	MAX. MA
FOCUS-ELECTRODE VOLTAGE	—500	MAX. VOLTS
BOMBARDED CATHODE:		
D-C VOLTAGE	2400	MAX. VOLTS
D-C CURRENT	750	MAX. MA
D-C POWER	1600	MAX. WATTS
COLLECTOR DISSIPATION	50	MAX. KILOWATTS

Supersedes sheet dated 8-17-53.

TYPICAL OPERATION

R-F LINEAR AMPLIFIER Television Visual Service
(In accordance with United States Federal
Communications Commission Standards)

Frequency	640	megacycles
Peak Synchronizing Level (80% of Saturation Power)		
Output Power	12	kilowatts
Driving Power	55	watts
Power Gain	23	db
Efficiency	32.4	percent
Black Level		
Output Power	7.2	kilowatts
Driving Power	33	watts
Power Gain	23	db
Efficiency	19.5	percent
D-C Beam Voltage	17.2	kilovolts
D-C Beam Current	2.15	amperes
D-C Body Current	100	milliamperes
D-C Collector Current	2.05	amperes
D-C Focus-Electrode Voltage	0	volts
Bombarded Cathode:		
Voltage*	2100	volts
Current*	660	milliamperes
Power	1400	watts
Magnetic-Coil Currents:*		
Prefocus	0.8	ampere
First Body	1.7	amperes
Second Body	2.5	amperes
Collector	1	ampere

*Approximate values.

NOTE: Driving power includes the power required to overcome losses inserted for broad-band operation.

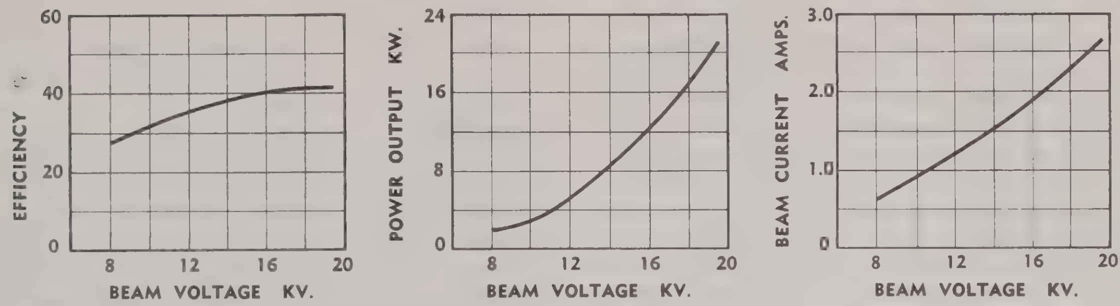
R-F AMPLIFIER Television Aural Service or Narrow-band CW

Frequency	640	megacycles
Output Power	10.7	kilowatts
Driving Power	17	watts
Power Gain	28	db
Efficiency	42.2	percent
D-C Beam Voltage	15	kilovolts
D-C Beam Current	1.65	amperes
D-C Body Current	90	milliamperes
D-C Collector Current	1.56	amperes
D-C Focus-Electrode Voltage	0	volts
Bombarded Cathode:		
Voltage*	2100	volts
Current*	660	milliamperes
Power	1400	watts
Magnetic-Coil Currents:*		
Prefocus	0.7	ampere
First Body	1.2	amperes
Second Body	1.7	amperes
Collector	0.8	ampere

*Approximate values.

NOTE: Driving power is the total power required by the tube and resonant circuit.

TYPICAL PERFORMANCE 3K50,000LA, F, Q KLYSTRON



EFFICIENCY, POWER OUTPUT AND BEAM CURRENT VS. BEAM VOLTAGE

APPLICATION

Mounting—Each klystron is provided with a mounting flange (see Outline Drawings) which may be used to support the tube with either end up.

Although satisfactory installations have been made with the collector end up, it is recommended that where feasible, the klystron be installed with the cathode end up. Standard Eimac Klystron Amplifier Circuit Assemblies are designed for this type of installation.

Filament Operation—The filament is designed to operate under space-charge-limited conditions. For maximum life, the pure tungsten filament should be operated just above the emission-limiting temperature. This temperature will be obtained with a filament voltage, as measured directly at the tube terminals, of approximately 8 volts.

Cathode Heating Power—The cathode is unipotential and heated by electron bombardment. With a d-c potential of approximately 2100 volts applied between the filament and cathode, the recommended cathode heating power of 1400 watts is obtained with approximately 0.66 ampere. For applications where relatively low beam voltages and currents are required, the cathode temperature may be decreased with a consequent increase in tube life. Cathode temperature is always varied by changing the bombarding potential between the filament and the cathode.

Cooling—Forced air is used to cool the electron-gun structure and the output cavity. Only clean, well-filtered air should be blown on the tube to avoid voltage breakdown due to dust accumulation.

The temperature of the metal in the region of the ceramic-to-metal seals should not exceed 150°C. Tube temperatures may be measured with the aid of a temperature-sensitive paint, such as "Tempilaq", obtainable from the Tempil Corporation, 132-34 West 22nd St., New York 11, N.Y. or from various chemical or scientific-equipment suppliers.

Water is used to cool the drift tubes and the collector assembly. The cooling water should be of sufficient purity to prevent the deposit of scale and consequent deterioration of cooling efficiency. The use of a closed system is recommended. The inlet water pressure at the drift tubes and collector assembly should not exceed 50 pounds per square inch and the outlet water temperature must not exceed a maximum of 70°C under any conditions.

Air and water flow should be started before filament and cathode power are applied. Simultaneous removal of power and cooling (as in the case of a power failure) will not ordinarily injure the tube, but it is not recommended as a standard operating practice. Following the removal of power, a nominal delay of two minutes is recommended before the removal of cooling.

Minimum cooling requirements for operation at maximum ratings and correct magnetic-field adjustment are tabulated below. For operation under conditions where collector dissipation is considerably less than the maximum rating, less water flow through the collector assembly may be justified provided that the outlet water temperature does not exceed 70°C. Water flow through the drift-tube jackets should not be less than the amounts specified under any conditions.

Water Cooling (Connections as noted on "Cooling Diagram")

	Volume	*Pressure Drop*
First Drift-Tube Jacket	1 gpm	1.6 psi
Second Drift-Tube Jacket	1 gpm	1.6 psi
Third Drift-Tube Jacket	1 gpm	1.6 psi
Fourth Drift-Tube Jacket	1 gpm	1.6 psi
Collector Assembly	25 gpm	28 psi

NOTE: All drift tubes may be series connected with 5/16-inch tubing with negligible additional pressure drop.

Air Cooling

	Volume	*Pressure Drop*
Electron-Gun Assembly (Using Eimac SK-110 Socket)	52 cfm	5 inches H_2O
Output Cavity	50 cfm	1.5 inches H_2O

Installation Precautions—While tuning the klystron and associated circuit assembly, it is very important that the operator have an unobstructed view of the body-current meter and the output-power meter while adjusting the position of the prefocus coil, cavity doors, and output coupling loop and the magnitude of coil

currents. If it is intended that the klystron circuit assembly be installed in a closed cabinet, the positioning adjustments may be accomplished through mechanical linkages or by means of remote-controlled motors.

To prevent distortion of the beam-controlling magnetic field it is important that no steel or iron objects be located near the circuit-assembly magnetic frame and that the assembly be isolated from strong fields. If the klystron circuit assembly is to be installed in a cabinet of ferrous material, it is important that it be symmetrically positioned within the enclosure and that cabinet sides are at least six and preferably twelve inches from the magnetic frame. Before starting the tuning procedure, all tools, nuts, bolts, etc. must be removed from the vicinity of the magnetic frame.

To protect the klystron ceramic window in the output cavity, it is important that the load presented to the output cavity be substantially "flat". A VSWR of 1.2 or less is satisfactory and means should be provided in the transmission line to allow continuous monitoring of this ratio.

Magnetic-Field Requirements—A magnetic frame, a prefocus coil, two body coils, and a collector coil are component parts of each of the three standard Eimac Klystron Amplifier Circuit Assemblies designed for use with these tubes. To establish and control the required magnetic field, a separate and smoothly-variable d-c power supply must be used to supply current to each of these coils. Each supply should be capable of five-percent voltage stability and have a ripple component of less than one percent.

The required voltage and current maximums for each magnetic coil of the circuit assembly designed for use with these three klystron types are tabulated below.

	LA	*LF*	*LQ*	
Prefocus-Coil Voltage	25	25	25	volts
Prefocus-Coil Current	1	1	1	ampere
Each of Two Body Coils:				
Voltage	265	175	175	volts
Current	3	3	3	amperes
Collector-Coil Voltage	100	50	50	volts
Collector-Coil Current	3	1.5	1.5	amperes

Note that a stronger field is required to control the beam of the 3K50,000LA. This is due to the greater inter-gap spacing and resultant greater total length inherent in the design of a klystron operable at the relatively low frequencies covered by this tube.

Power Supplies—Magnetic-coil power-supply requirements are outlined above. Other power supplies used in the installation of one of these klystrons are listed below with minimum stability and ripple requirements.

Power Supply	*Percent Stability*	*Percent Ripple*
Filament	5	......
Cathode Bombarder	5	4
Beam	5	0.1

The focus electrode in each of these klystron types is normally operated at zero potential with respect to the cathode. In cases where it is desired to operate with bias on the focus electrode, the supply should have a stability of one percent or better and a ripple component of less than 0.03 percent. It should also incorporate a bleeder drawing at least 10 milliamperes.

In installations where it is desired to obtain this bias from the bombarder supply, means must be provided to assure that the voltage applied to the focus electrode meets the minimum stability and ripple requirements outlined above.

CAUTION—Since it is convenient to operate the r-f and collector portions of the tube at ground potential, the cathode, filament, and focus electrode are normally at high negative potentials with respect to ground. Filament, cathode, and focus-electrode (when used) power supplies and voltmeters must be adequately insulated for these high voltages and protection must be provided for operating personnel.

Tuning Precautions—The following precautions must be observed in the tuning or operation of these klystrons.

(1) The output cavity must be overcoupled (maximum coupling is obtained with the output-coupling loop in a vertical position) at all times with one to five-percent less than maximum output power delivered to the load under normal operating conditions. Additional overcoupling, with a resultant ten-percent decrease in output power, is required before raising beam voltage or making any adjustment that may result in an increase of output power.

(2) The middle cavity must be tuned to the high-frequency side of resonance at all times. It must be further detuned to a higher frequency, with a resultant additional ten-percent decrease in output power, prior to raising beam voltage, retuning the input cavity, or increasing driving power.

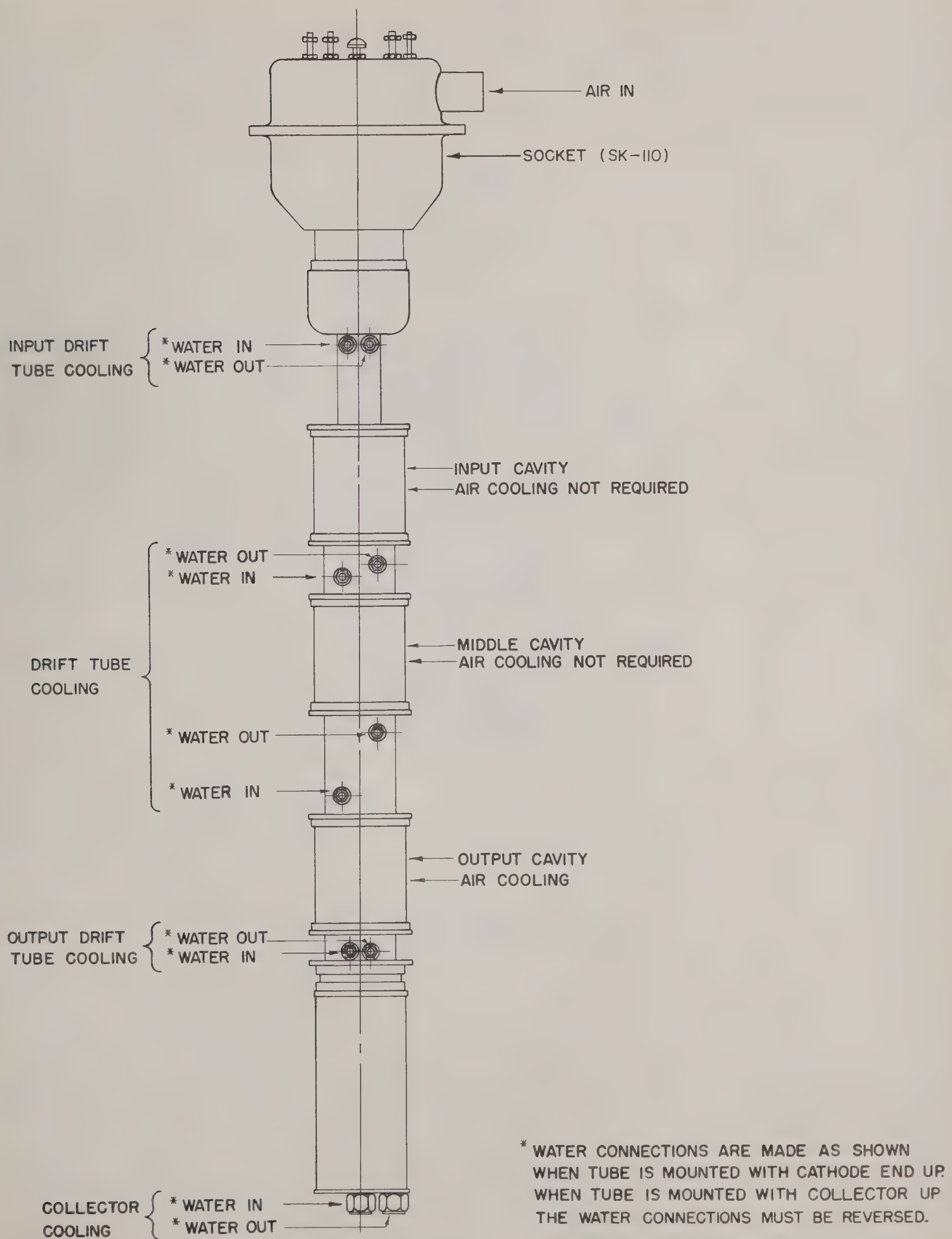
(3) The position of the prefocus coil should not be adjusted while operating at beam voltages higher than ten kilovolts.

For more detailed tuning instructions, write to the Application Engineering Department, Eitel-McCullough, Inc.

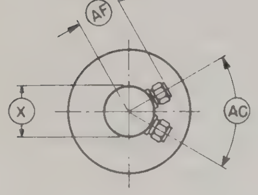
Protection—It is recommended that the following protective devices be installed in any system employing one of these klystrons.

(1) Interlocks in air and water supplies
(2) Interlocks in magnetic-field supply circuits.
(3) Current overload in cathode-bombardment supply circuit.
(4) Current overload in beam-current supply circuit.
(5) Current overload in body-current circuit.
(6) Current-limiting resistor of approximately 100 ohms in series with beam power supply to isolate tube from final capacitor of supply.
(7) Protective device in output coaxial line to turn off either driving power or beam voltage in the event of an increase in reflected power or VSWR.

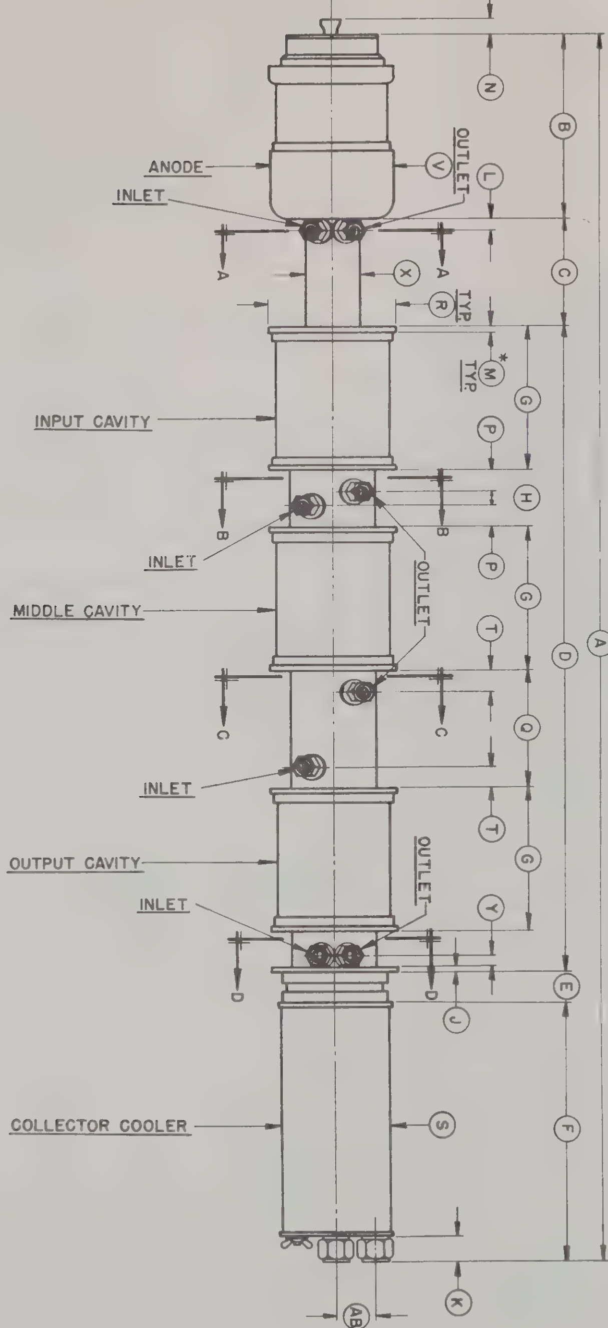
Special Applications—If it is desired to operate one of these klystrons under unusual conditions or over frequency ranges other than those listed, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California for information and recommendations.



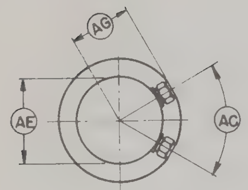
COOLING DIAGRAM



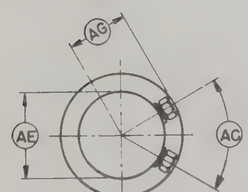
SECTION A-A



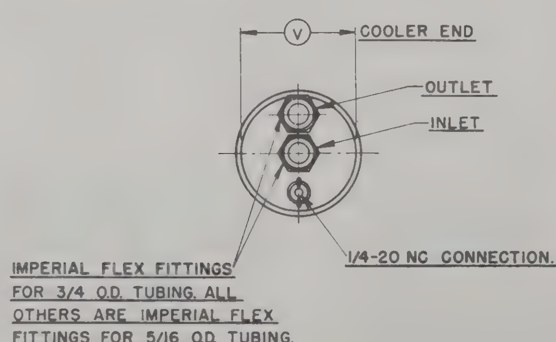
DIMENSION DATA			
REF.	NOM:	MIN.	MAX.
A		51.245	51.365
B		7.475	7.510
C		4.490	4.525
D		26.730	26.760
E		1.245	1.270
F		11.285	11.350
G		5.095	6.020
H		2.350	2.380
J		.235	.255
K		1.055	1.190
L		.495	.550
M		.187	
N	.750		
P		.870	.920
Q		4.855	4.880
R		5.118 DIA.	5.125 DIA.
S		4.490 DIA.	4.505 DIA.
T		.870	.920
U		5.118 DIA.	5.128 DIA.
V		4.620 DIA.	4.630 DIA.
X		2.120 DIA.	2.135 DIA.
Y		.430	.445
AB		1.560	1.630
AC	60°		
AD	30°		
AE		3.495 DIA.	3.510 DIA.
AF	1.875		
AG	2.5625		



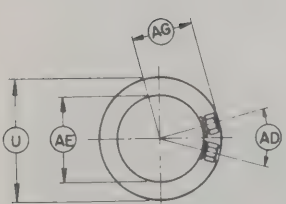
SECTION B-B



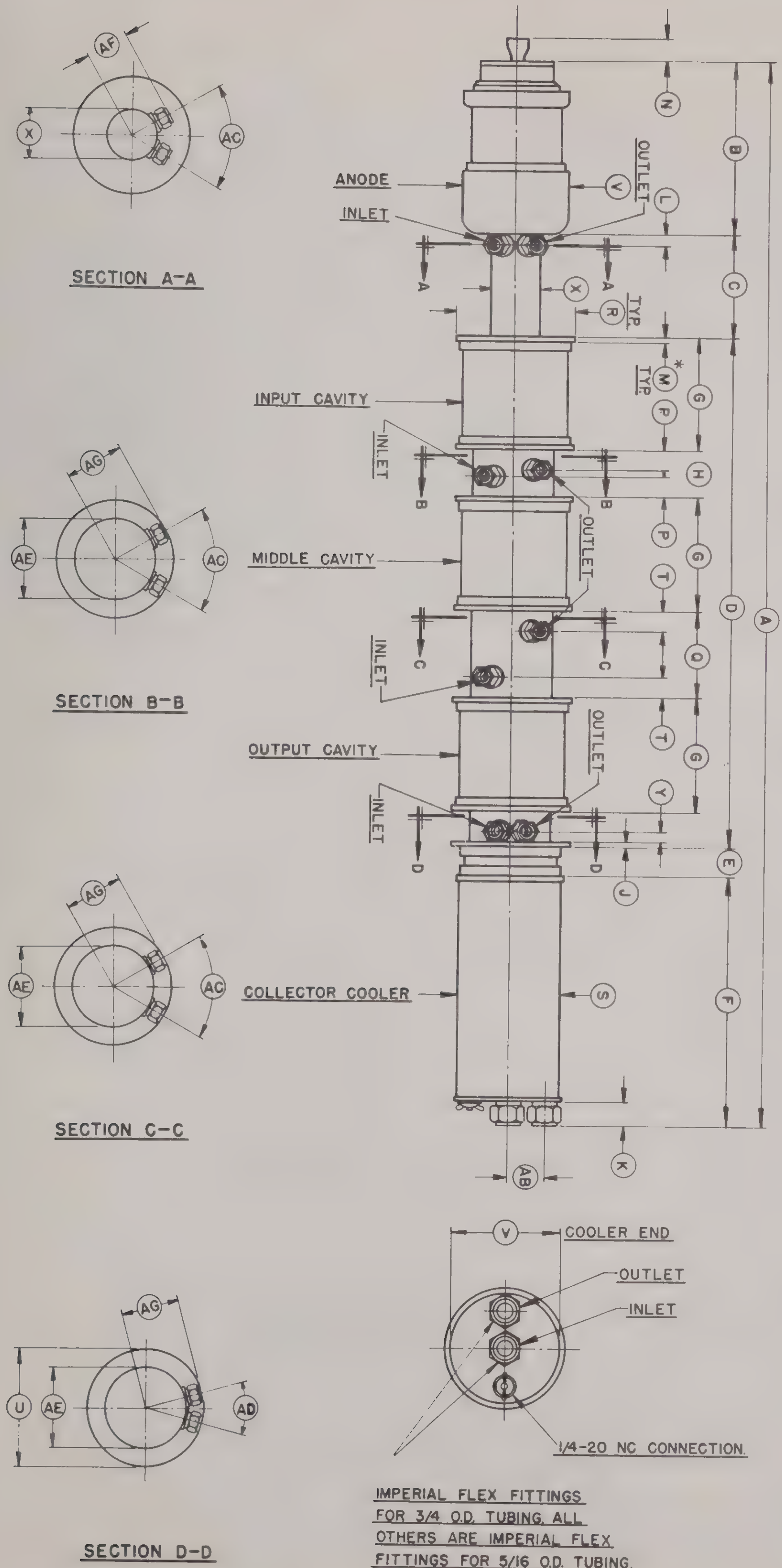
SECTION C-C



3K50,000LA
OUTLINE DRAWING

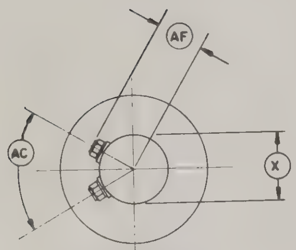


SECTION D-D

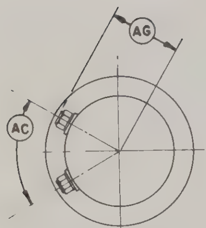


DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		46.745	46.865
B		7.475	7.510
C		4.490	4.525
D		22.230	22.260
E		1.245	1.270
F		11.285	11.350
G		4.095	5.020
H		1.975	2.005
J		.235	2.55
K		1.055	1.190
L		.495	.550
M		.187	
N	.750		
P		.870	.920
Q		3.730	3.755
R		5.118 DIA.	5.128 DIA.
S		4.490 DIA.	4.505 DIA.
T		.870	.920
U		5.118 DIA.	5.128 DIA.
V		4.620 DIA.	4.630 DIA.
X		2.120 DIA.	2.135 DIA.
Y		.430	.445
AB		1.560	1.630
AC	60°		
AD	30°		
AE		3.495 DIA.	3.510 DIA.
AF	1.875		
AG	2.563		

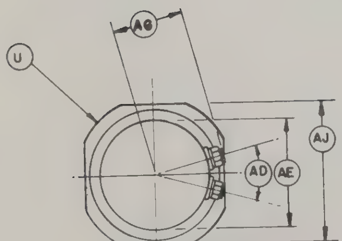
3K50,000LF
OUTLINE DRAWING



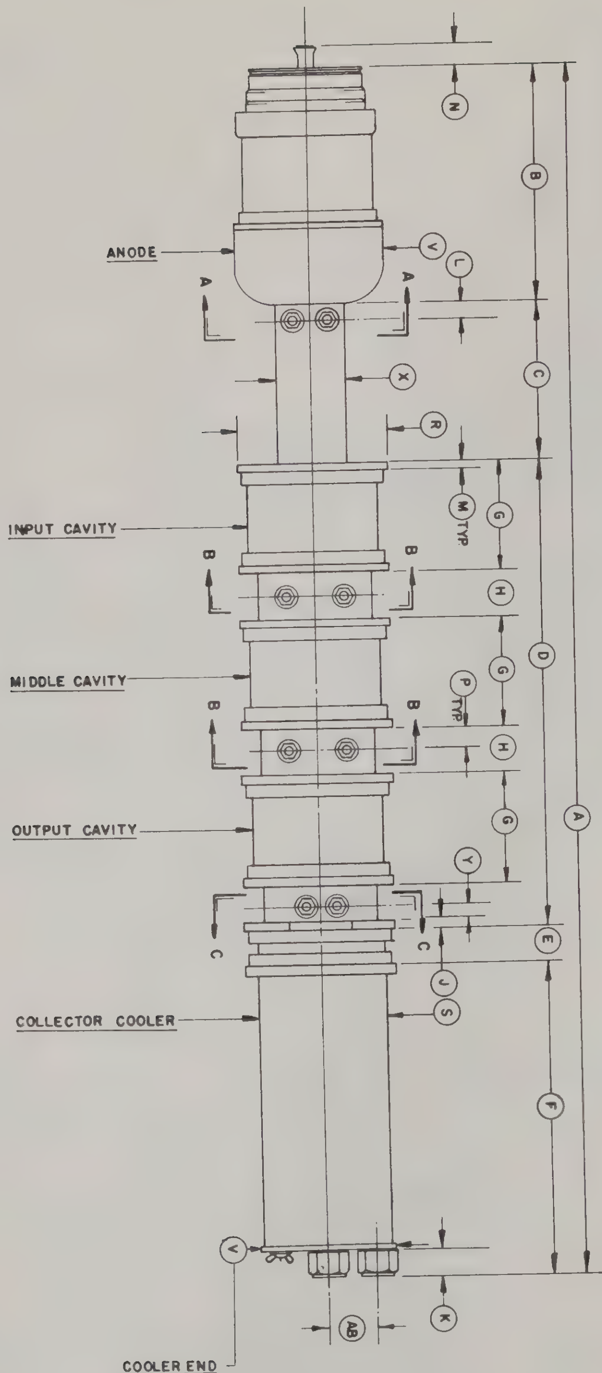
SECTION A-A



SECTION B-B

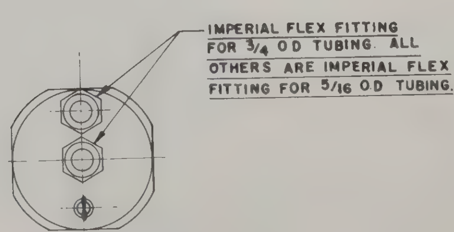


SECTION C-C



DIMENSION DATA		
REF.	MIN.	MAX.
A	39.875	
B	74375	7.6875
C	5.000	
D	14 875	
E	1.250	
F	11 1875	
G	3 500	
H	1.4375	
J	.250	
K	1.0625	
L	.5625	
M	.250	
N	.750	
P	.719	
R	4. 625 DIA	
S	4.500	
U	5.1875 DIA	
V	4.625 DIA	
X	2.125	
Y	.4375	
AB	1.625	
AC	60°	
AD	30°	
AE	3.500	
AF	1.875	
AG	2.5625	
AJ	4.625	

3K50,000LQ
OUTLINE DRAWING



COLLECTOR END VIEW

Printed in U.S.A.

Eimac®

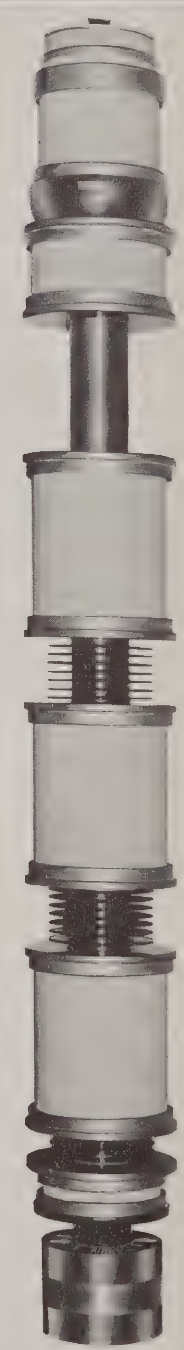
EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

3KM3000LA

POWER-AMPLIFIER

L-BAND KLYSTRON



The Eimac 3KM3000LA is a ceramic and metal, three-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 375 and 585 megacycles. It will deliver two kilowatts CW, one kilowatt AM carrier, or 20 kilowatts pulse output power.

This klystron employs the Eimac modulating anode which provides an effective method of amplitude or pulse modulating the output power without changing beam voltage.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-120) has been designed for use with the 3KM3000LA and covers the range of 385 to 580 megacycles. Other frequency ranges can be provided if required. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated		
	Minimum Heating Time	5	minutes
Heater:	Voltage	5	volts
	Current	31	amperes
	Maximum Starting Current	60	amperes
Modulating-Anode Capacitance			
	(To all other electrodes)	21	uuf
Power Gain (Narrow-Band CW)		30	db
Output Power (Narrow-Band CW)		2000	watts
Frequency Range (In H-120 Assembly)		385 to 580	mc

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (H-120 Components)

Prefocus-Coil Voltage		0 to 50	volts
Prefocus-Coil Current		0 to 1.5	amperes
Each of Two Body Coils:			
	Voltage	0 to 175	volts
	Current	0 to 3	amperes
Collector-Coil Voltage		0 to 50	volts
Collector-Coil Current		0 to 1.5	amperes

MECHANICAL

Operating Position*	Axis vertical
R-F Input Coupling	Type "N" coaxial fitting
R-F Output Coupling	1 5/8-inch 50-ohm air line
Net Weight	46 pounds
Shipping Weight (Approximate)	130 pounds

Cooling for Operation at Maximum Ratings:	Flow Rate	Pressure Drop
Cathode (With Eimac SK-100 Socket)	5 cfm air	0.4 inch H_2O
Output Cavity	50 cfm air	1.0 inch H_2O
Collector	150 cfm air	1.6 inches H_2O

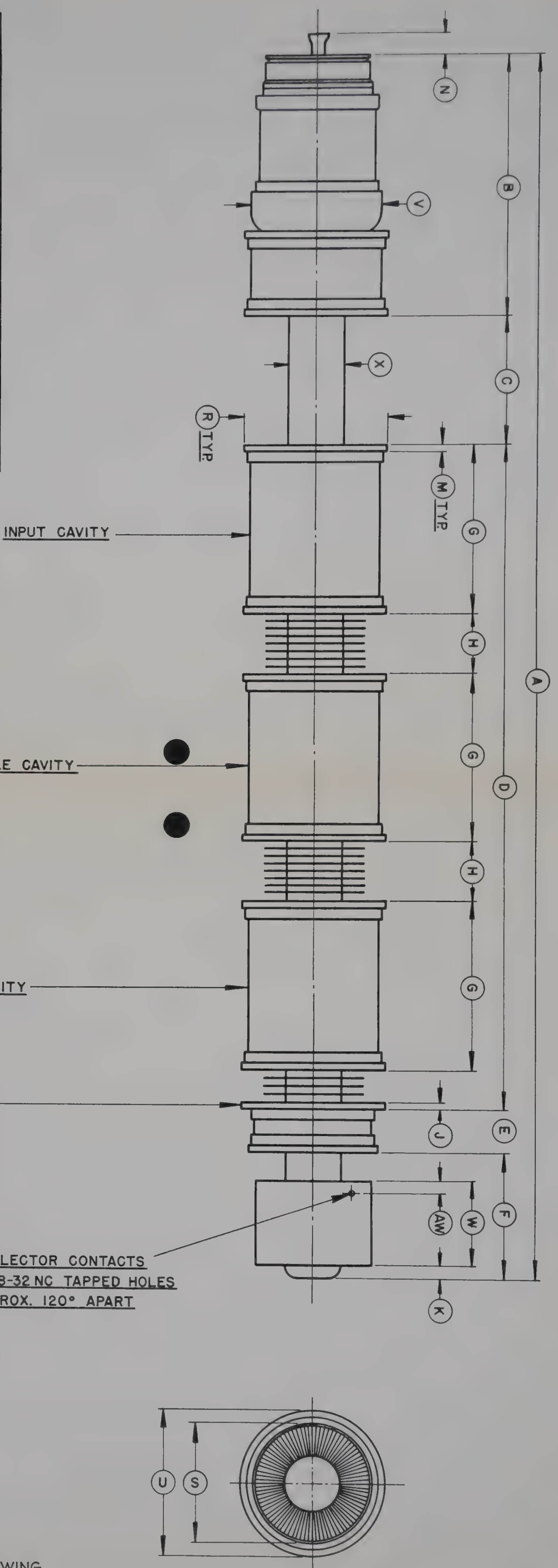
*Cathode end up when installed in H-120 circuit assembly.

3KM3000LA

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		43.185	43.480
B		9.125	9.330
C		4.495	4.635
D		23.620	23.670
E	1.510		
F		4.360	4.430
G		5.995	6.025
H		2.120	2.140
J		.235	.260
K		.375	.410
M		.187	
N	.750		
R		5.118 DIA.	5.132 DIA.
S		4.125 DIA.	4.140 DIA.
U		5.118 DIA.	5.132 DIA.
V		4.615 DIA.	4.650 DIA.
W		2.950	3.125
X		1.990	2.010
AW		.405	.505

NOTES:

1. DIMENSIONS IN INCHES.



3KM3000LA OUTLINE DRAWING

MAXIMUM RATINGS

D-C BEAM VOLTAGE (PULSE OPERATION)	20 MAX.	KILOVOLTS
D-C BEAM VOLTAGE (CW OPERATION)	9 MAX.	KILOVOLTS
PEAK D-C BEAM CURRENT	2.8 MAX.	AMPERES
AVERAGE D-C BEAM CURRENT	750 MAX.	MA
D-C BODY CURRENT (CONTINUOUS)	75 MAX.	MA
D-C BODY CURRENT (TUNING ONLY)	100 MAX.	MA
D-C FOCUS-ELECTRODE VOLTAGE	-500 MAX.	VOLTS
COLLECTOR DISSIPATION	3 MAX.	KILOWATTS

TYPICAL OPERATION
(In H-120 Circuit Assembly)

NARROW-BAND PULSE AMPLIFIER, 400-450 MEGACYCLES, 0.06 DUTY, MODULATING ANODE PULSED

Peak Output Power	12.25	kilowatts
Peak Driving Power	10	watts
Peak Power Gain	30.9	db
D-C Beam Voltage	15	kilovolts
Peak D-C Beam Current	1.74	amperes
Peak D-C Beam Input Power	26.2	kilowatts
Beam Power Efficiency	47	percent
Peak D-C Body Current	100	milliamperes
Peak D-C Collector Current	1.64	amperes
Peak D-C Modulating-Anode Voltage	15	kilovolts
Focus-Electrode Voltage	0	volts
Magnetic-Coil Currents:*		
Prefocus	1.0	ampere
First Body	2.7	amperes
Second Body	2.7	amperes
Collector	1.5	amperes

NARROW-BAND CW AMPLIFIER, 520 MEGACYCLES

Output Power	0.9	2.3	kilowatts
Driving Power	1	2	watts
Power Gain	29.5	30	db
D-C Beam Voltage	6	9	kilovolts
D-C Beam Current	370	590	milliamperes
Beam Input Power	2.58	5.3	kilowatts
Beam Power Efficiency	40.5	43.4	percent
D-C Body Current	25	40	milliamperes
D-C Collector Current	345	550	milliamperes
Focus-Electrode Voltage	-200	-200	volts
Magnetic-Coil Currents:*			
Prefocus	0.65	0.7	ampere
First Body	2.0	2.0	amperes
Second Body	1.1	1.6	amperes
Collector	1.0	1.0	ampere

*Approximate values.

APPLICATION

If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California.

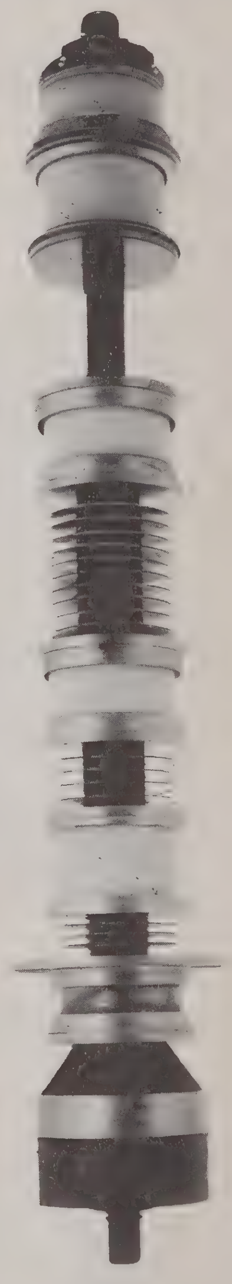
Printed in U.S.A. 834

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

3KM4000LT

PULSE AMPLIFIER L-BAND KLYSTRON



The Eimac 3KM4000LT is a three-cavity, magnetically focused, pulse-amplifier klystron. It will deliver a peak output power of 40 kilowatts with an average power of one kilowatt at frequencies between 960 and 1215 megacycles. Nominal power gain is 33 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. A modulating anode voltage of approximately one half the beam voltage is sufficient to realize full rated pulse output power.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-116 has been designed for use with the 3KM4000LT to cover the frequency range of 960 to 1215 megacycles. This assembly includes a klystron supporting structure, focus coils, tuning cavities and an adjustable output load coupler.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide-Coated		
	Minimum Heating Time	5	minutes
Heater:	Voltage	7.5	volts
	Current	5.5	amperes
	Maximum Starting Current	11	amperes
Modulating Anode Capacitance (To all other electrodes)		22	uuf
Power Gain (Nominal)		33	db
Average Output Power		1	kilowatt
Peak Output Power		40	kilowatts
Frequency Range (In H-116 Assembly)		960 to 1215	megacycles

MECHANICAL

Operating Position	Vertical, cathode end up
RF Input Coupling	50-ohm Type "N"
RF Output Coupling	1-5/8 inch, 50-ohm line
Weight (Tube Only)	21 pounds
Approximate Shipping Weight (Klystron only)	120 pounds
Weight (H-116 Circuit Assembly)	240 pounds

MECHANICAL (Cont'd)

Maximum Dimensions (Tube):

Length	31	inches
Diameter	5.3	inches

Maximum Dimensions (Tube and Circuit Assembly):

Length	31	inches
Diameter	19	inches

Cooling:

Cathode and Drift Tubes - Convection air cooling is adequate at sea level up to 25° C ambient air temperature. Forced-air cooling may be required at higher altitudes or higher temperatures.

Collector - - - - - 150 cfm air with pressure drop of 1.85 inches H_2O (25° C inlet air at sea level).

FOCUS COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil Voltage	0 to 25	volts
Prefocus-Coil Current	0 to 1.5	amperes
Body-Coil Voltage	0 to 25	volts
Body-Coil Current	0 to 10	amperes
Collector-Coil Voltage	0 to 50	volts
Collector-Coil Current	0 to 2.5	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	28	KILOVOLTS
PEAK MODULATING-ANODE VOLTAGE	14	KILOVOLTS
PEAK BEAM CURRENT	6	AMPERES
AVERAGE BEAM CURRENT	500	MILLIAMPERES
DC BODY CURRENT (CONTINUOUS)	20	MILLIAMPERES
DC BODY CURRENT (TUNING ONLY)	40	MILLIAMPERES
DC FOCUS ELECTRODE VOLTAGE	-400	VOLTS
COLLECTOR DISSIPATION	4	KILOWATTS
SEAL TEMPERATURE	175	DEGREES C

TYPICAL OPERATION

(In H-116 Circuit Assembly)

NARROW-BAND PULSE AMPLIFIER, SQUARE PULSE, 0.025 DUTY, MODULATING ANODE PULSED

DC Beam Voltage	24	26	28	kilovolts
Peak Output Power	30	36	40	kilowatts
Peak Driving Power	5	5	5	watts
Power Gain	37.7	38.5	39	db
Peak Beam Current	2.8	3.3	3.7	amperes
Average Beam Current	71	82	90	milliamperes
DC Body Current	13	14	15	milliamperes
Peak Modulating-Anode Voltage	12	13	14	kilovolts
Focus-Electrode Voltage	-75	-75	-75	volts
Focus Coil Currents:				
Prefocus	0.92	1.1	1.2	amperes
Body	6.8	7	7	amperes
Collector	0.95	1.0	1.0	ampere

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California.

TENTATIVE DATA

3KM50,000PA

POWER-AMPLIFIER
P-BAND KLYSTRON

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

The Eimac 3KM50,000PA is a three-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 225 and 400 megacycles and will deliver a minimum output power of 20 kilowatts CW, or 10 kilowatts AM carrier, with a minimum power gain of 30 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 3KM50,000PA are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-126, for use with the 3KM50,000PA, covers the frequency range of 225 to 400 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, input and output r-f load couplers and an Eimac SK-110 Air-System Socket. The H-126 Klystron Amplifier Circuit Assembly conforms generally to Military Environmental Specification MIL-E-4970A (USAF) and the general Military specification, MIL-E-4158B (USAF), for electronic ground equipment.

CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Heater:	Voltage (±5%)		7.5		volts
	Current (Normal)	38		42	amperes
	Max. Starting Current			80	amperes
Cathode:	EMA, Unipotential				
	Heating Time	5			minutes
Getter (Operating):	Voltage		2.0		volts
	Current		36.0		amperes
Power Gain:	(Narrow Band)		36		decibels
Output Power:	CW	20			kilowatts
	AM Carrier (90% Modulated)		10		kilowatts
Frequency Range			225 to 400		megacycles

MECHANICAL

Operating Position	-	-	-	-	Vertical, cathode end up
R-F Input Coupling	-	-	-	-	50-Ohm Type N, UG-58A
R-F Output Coupling	-	-	-	-	50-Ohm, 6-1/8" line
Weight:					
3KM50,000PA	-	-	-	-	163 pounds
H-126 Circuit Assembly		-	-	-	1940 pounds

Cooling: Water or 60% Ethylene-Glycol solution and Forced Air

		Flow Rate	Pressure Drop
Cathode (With SK-110 Socket)	-	*25 cfm air	1 inch H_2O
Output Cavity - -	-	*100 cfm air	2 inches H_2O
Four Drift-Tube Jackets in Series		4 gpm	(see curves)
Collector - -	-	(see collector cooling curves)	

MAXIMUM RATINGS

	CW	AM	
D-C BEAM VOLTAGE - - -	23.0	30.0	KILOVOLTS
D-C BEAM CURRENT - - -	2.75	2.0	AMPERES
D-C MODULATING ANODE VOLTAGE -	23.0	17.0	KILOVOLTS
PEAK MODULATING ANODE VOLTAGE -	----	±13.0	KILOVOLTS
D-C FOCUS ELECTRODE VOLTAGE -	-500	-500	VOLTS
D-C BODY CURRENT - - -	250	250	MILLIAMPERES
A-C GETTER CURRENT - - -	50	50	AMPERES
COLLECTOR DISSIPATION - - -	60	60	KILOWATTS
SEAL TEMPERATURES - - -	175	175	DEGREES C

TYPICAL OPERATION (In H-126 Circuit Assembly)

NARROW-BAND CW AMPLIFIER, Tuned for Maximum Output Power.

Frequency - -	300	400	400	400	megacycles
Output Power - -	24.4	8.93	19.8	23.1	kilowatts
Driving Power - -	5.0	5.0	5.0	5.0	watts
Power Gain - -	36.9	32.5	35.9	36.6	decibels
D-C Beam Voltage -	23.0	18.0	22.0	23.0	kilovolts
D-C Beam Current -	2.6	1.83	2.55	2.6	amperes
Beam Input Power -	59.8	32.9	56.0	59.8	kilowatts
Beam Power Efficiency -	40.8	27.0	35.2	38.6	percent
D-C Body Current -	110	50	80	120	milliamperes
D-C Collector Current -	2.49	1.78	2.47	2.48	amperes
Focus Electrode Voltage -	-285	-200	-200	-285	volts
Prefocus Coil Current -	0.9	0.8	0.9	0.9	ampere

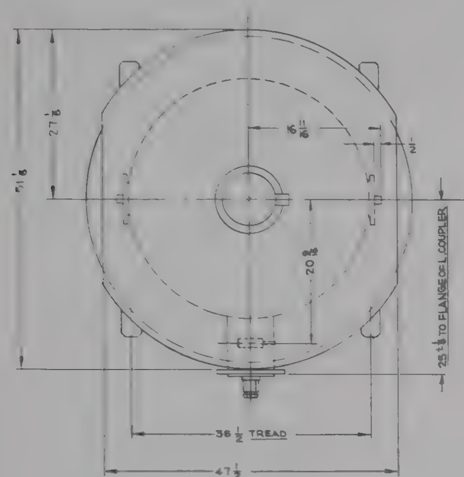
AMPLITUDE MODULATED

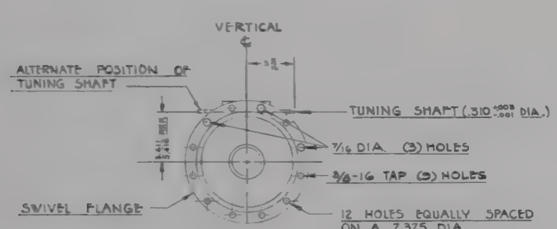
Modulation - - - -	90	90	percent
Output Power (average) - - -	13.2	14.3	kilowatts
Driving Power - - - -	5.3	8.8	watts
Power Gain - - - -	32.7	32.1	decibels
D-C Beam Voltage - - -	27.8	29.5	kilovolts
D-C Beam Current - - -	1.74	1.85	amperes
Beam Input Power - - -	48.4	54.6	kilowatts
Beam Power Efficiency (average) - -	27.2	26.2	percent
D-C Body Current - - -	40	49	milliamperes
D-C Collector Current - - -	1.7	1.8	amperes
Focus Electrode Voltage - - -	-166	-200	volts
D-C Modulating Anode Voltage - -	16.7	17.0	kilovolts
Total RMS Harmonic Distortion - -	3.3	3.9	percent

*At sea level with 30° C inlet air temperature.

BODY COIL AND COLLECTOR COIL CURRENTS FOR ALL OPERATING CONDITIONS
(H-126 Assembly)

First Body Coil	10.0	amperes
Second Body Coil	12.5	amperes
Third Body Coil	15.0	amperes
Fourth Body Coil	17.5	amperes
Collector Coil	4.5	amperes





END VIEW OF LOAD COUPLER (ITEM #7)

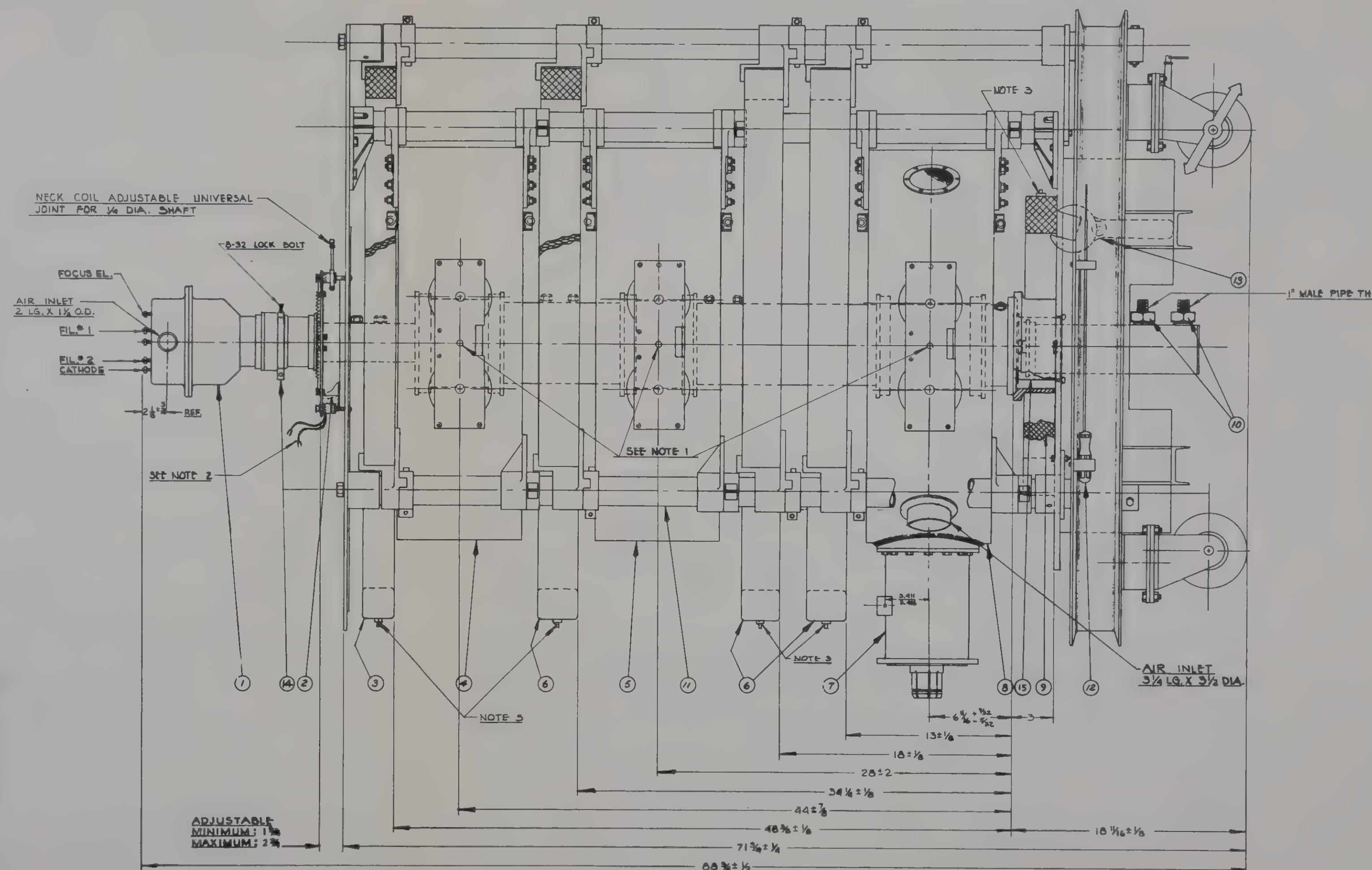
NOTES:
1. TUNING DRIVE, 1 7/16 LG. X .500 DIA.
2. 2 FT. WIRE LEAD WITH SPADE LUGS, AMP 32562
3. AMPHENOL MS-3102A-18-5P RECEPTACLE

ITEM NO.	CATALOG NO. USE FOR REPLACEMENT ORDERING	NAME	REQ
1	SK-110	SOCKET ASSEMBLY	1
2	MC-233	PREFOCUS COIL	1
3	MC-225	TOP BODY COIL	1
4	RF-440	INPUT TUNING BOX	1
5	RF-441	MIDDLE TUNING BOX	1
6	MC-226	BOTTOM BODY COIL	3
7	LC-319	LOAD COUPLER	1
8	RF-442	OUTPUT TUNING BOX	1
9	MC-234	COLLECTOR COIL	1
10	HC-100	COLLECTOR HOSE FITTING	2
11	MF-121	MAGNETIC FRAME	1
12	HT-103	SPECIAL LONG SOCKET WRENCH	1
13	HT-104	WRENCH FOR COLLECTOR HOSE COUPLING	1
14	SK-112	MODULATING ANODE CONNECTOR	1
15	SK-113	GETTER CLAMP	1

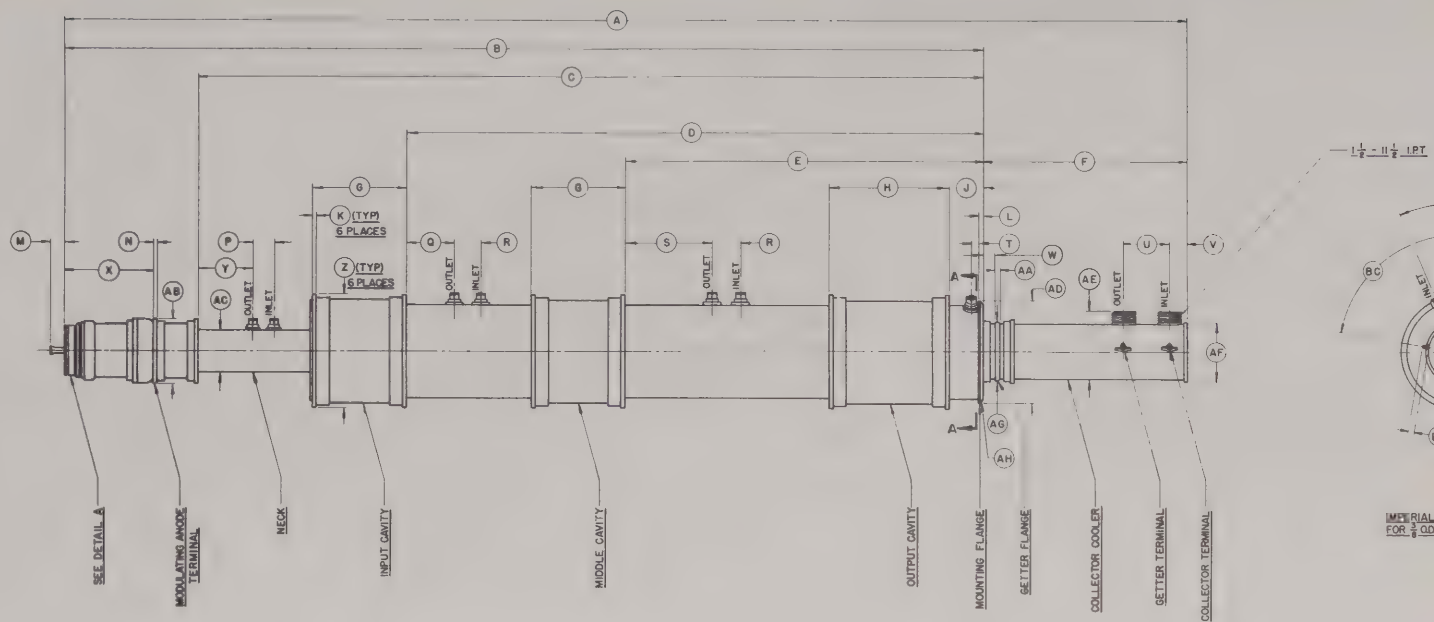
MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS
(Eimac H-126 Klystron Amplifier Circuit Assembly)

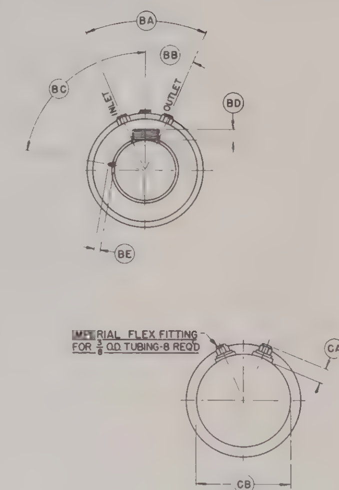
		Min.	Max.	
Prefocus Coil:	Voltage (dc)	0	25	volts
	Current (dc)	0	2	amperes
Each of Four Body Coils:				
	Voltage (dc)	0	40	volts
	Current (dc)	0	20	amperes
Collector Coil:				
	Voltage (dc)	0	40	volts
	Current (dc)	0	6.5	amperes

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

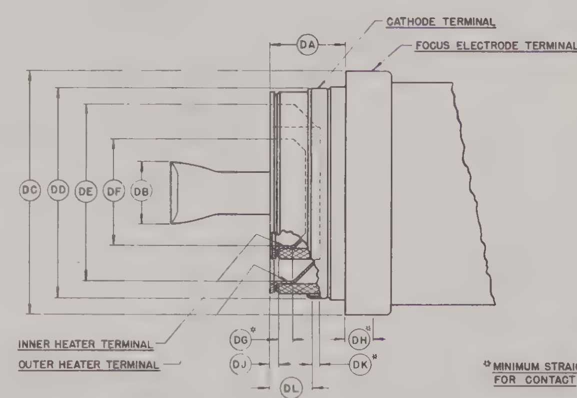


H-126 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY





SECTION A-A

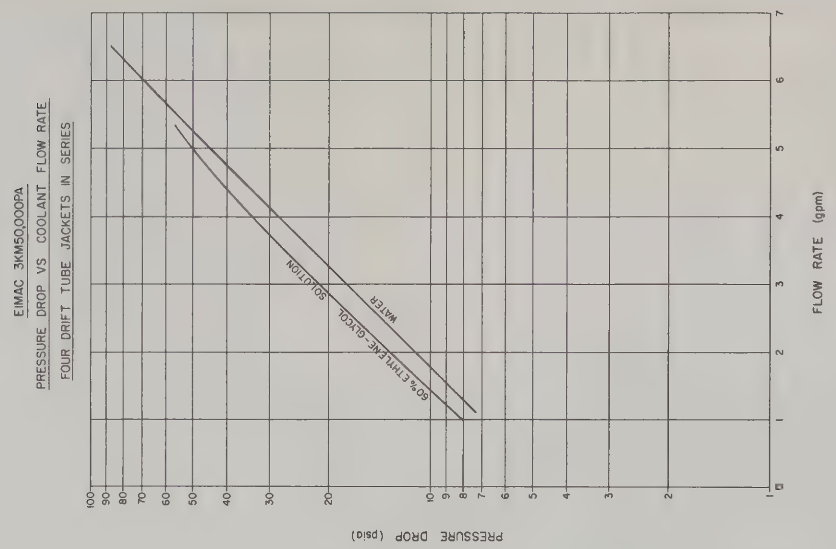


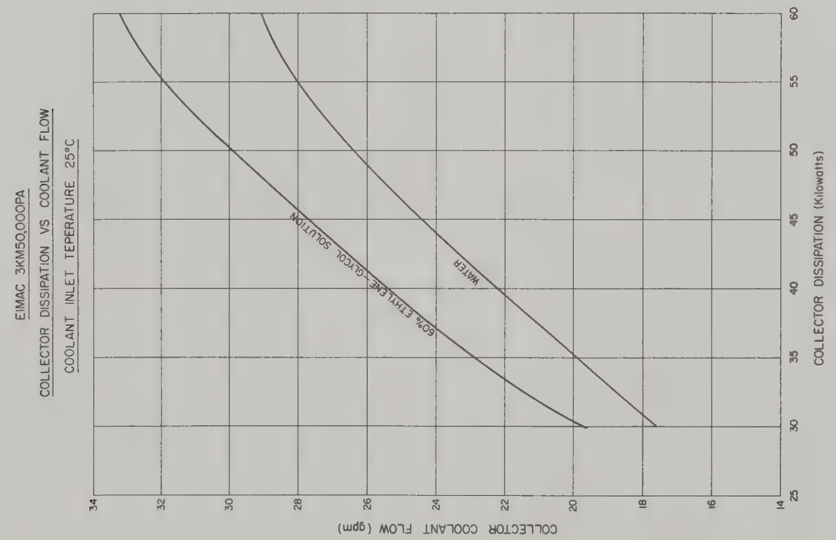
DETAIL A

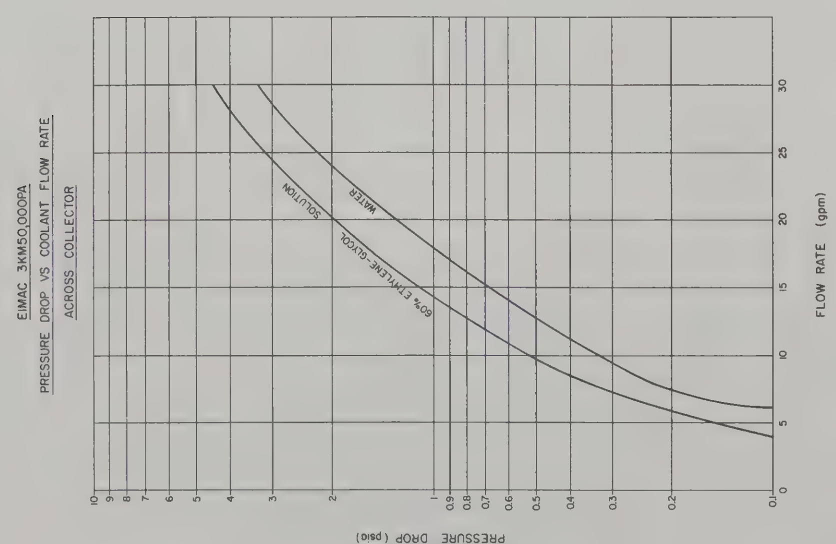
* MINIMUM STRAIGHT SURFACE FOR CONTACT

DIMENSION DATA							
REF	NOM	MIN	MAX	REF	NOM	MIN	MAX
PRE-PRODUCTION				DC		4.300	4.450
A		78.610	80.255	DD		3.750	3.835
P		1.450	1.550	DE		3.100	3.200
Q		3.300	3.400	DF		1.865	1.950
R		1.900	2.150	DG		.100	
S		6.550	6.650	DH		.100	
T		.400	.480	DJ		.125	.175
U		3.200	3.300	DK		.100	
V		1.100	1.300	DL		.670	.775
Y		3.800	4.000	PRODUCTION			
AE		4.875	5.125	B		64.360	65.505
AF		4.165	4.215	C		55.260	55.860
BA		40°	50°	D		40.475	41.100
BB		17.5°	27.5°	E		25.100	25.500
BC		75°	85°	F		14.250	14.750
BD		.600		G		6.700	6.800
BE		.450	.550	H		8.650	8.800
CA		.900	1.125	J		2.300	2.400
CB		6.625	7.000	M			1.750
DESIGN				W		.800	.865
K		.355	.395	X		6.190	6.320
L		.335	.365	Z		8.110	8.140
N		.235	.265	AB		4.610	4.[illegible]40
AA		.225	.275	AD		8.110	8.140
AC		3.100	3.150	DA		1.000	1.500
AG		4.240	4.290	DB			1.188
AH		.475 R.	.525 R.				

3KM50000PA KLYSTRON







Printed in U.S.A. 856

Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4K3CB

POWER AMPLIFIER C-BAND KLYSTRON

The Eimac 4K3CB is an air cooled, permanent magnet focused, power amplifier klystron. It will deliver a minimum CW output power of one kilowatt at frequencies from 4.4 to 5.0 kMc, with a minimum power gain of 43 db. The 4K3CB is designed for use in transmitters where compactness and light weight are essential.

FEATURES

FREQUENCY	4.4-5.0	kMc
MINIMUM OUTPUT POWER	1	kW
HALF POWER BANDWIDTH	7.5	Mc
MINIMUM POWER GAIN	43	db

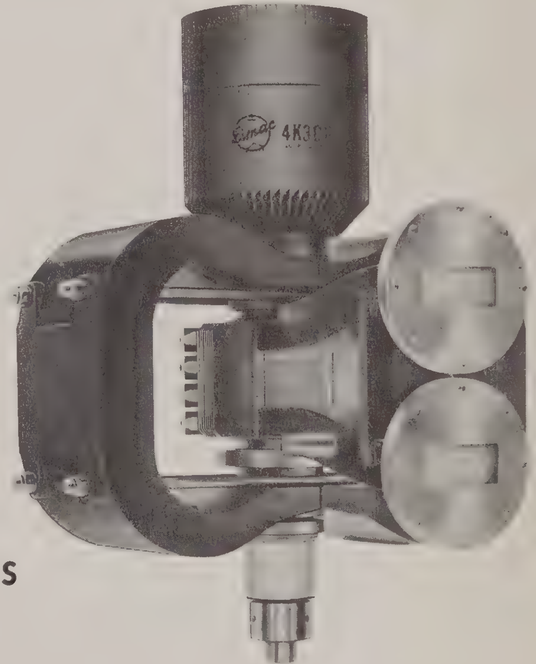
AIR COOLING

PERMANENT MAGNET FOCUSING

FOUR INTEGRAL CAVITIES

FIXED INPUT AND OUTPUT COUPLING

INSTANT FAULT RECYCLING



CHARACTERISTICS

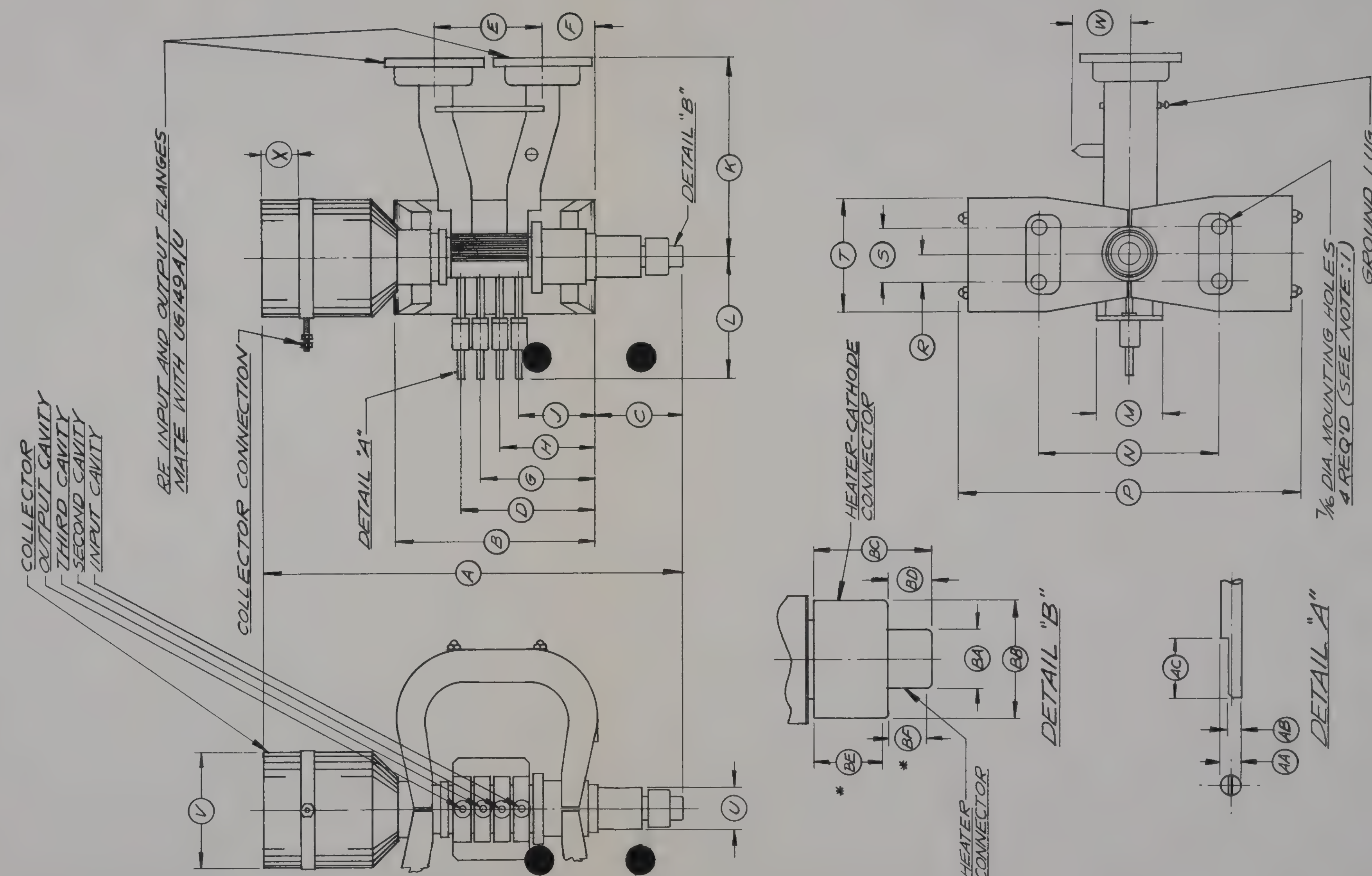
ELECTRICAL

Cathode:	Impregnated, Unipotential		
	Heating Time	3	minutes
Heater:	Voltage	6.5	volts
	Current	7.5	amperes
	Maximum Starting Current	15	amperes

MECHANICAL

Maximum Dimensions:		
Length	15-1/2	inches
Width	12-13/16	inches
Depth	11-15/16	inches
Maximum Weight (Tube and Magnet)	60	pounds
Input Coupling	UG149A/U	waveguide
Output Coupling	UG149A/U	waveguide
Maximum Tuner Torque	30	in-oz
Mounting Position Preferred	Vertical, cathode down	

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A			15.500
B			7.500
C	2.723		
D	5.104		
E		3.629	3.879
F	2.281		
G	4.409		
H	3.714		
J	3.019		
K		7.038	7.288
L		4.481	4.605
M		2.328	2.359
N		6.500	6.625
P			12.812
R		.937	1.000
S		1.969	2.031
T			4.600
U			1.627
V		4.333	4.433
W			2.750
X		.875	1.125
AA		.248	.250
AB		.170	.180
AC		.740	.760
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		.530	
BE		.830	
BF		.450	



NOTES:
1. KEEP MAGNETIC MATERIAL AT LEAST SIX INCHES AWAY FROM MAGNET; OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT SURFACES.

4K3CB KLYSTRON

MECHANICAL (continued)

Cooling: Forced Air (20° C at Sea Level)

	Flow Rate	Pressure Drop
Tuner (Ducted)	60 cfm	0.25 inches H_2O
Body	60 cfm	free
Collecter (Ducted)	200 cfm	2 inches H_2O

MAXIMUM RATINGS

DC BEAM VOLTAGE	8.0	KILOVOLTS
DC BEAM CURRENT	0.6	AMPERE
DC BEAM INPUT POWER	4	KILOWATTS
DC BODY CURRENT	60	MILLIAMPS
COLLECTOR DISSIPATION	4	KILOWATTS
LOAD VSWR	2:1	
TEMPERATURE OF COLLECTOR, BODY AND TUNER FINS	150° C	

TYPICAL OPERATION - TUNED FOR MAXIMUM EFFICIENCY

Frequency	4.4	4.7	5.0	kilomegacycles
Output Power	1.42	1.32	1.22	kilowatts
Driving Power	40	40	40	milliwatts
Gain	45.5	45	44.8	decibels
DC Beam Voltage	7.5	7.5	7.5	kilovolts
DC Beam Current	0.465	0.465	0.465	ampere
Beam Power Efficiency	40.7	37.8	35	percent
Half Power Bandwidth	7.5	8	9	megacycles
DC Body Current	21	21	18	milliamperes

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM50SK

POWER AMPLIFIER S-BAND KLYSTRON

The Eimac 4KM50SK is a power-amplifier klystron designed to operate at frequencies from 2550 to 2700 megacycles with a rated output power of 10 kilowatts and a minimum gain of 40 decibels. This tube is a member of Eimac's new family of S-band klystrons which also includes the 4KM70SJ, 4KM70SK, 5KM70SF, 5KM70SJ, 5KM50SJ and 4KM50SJ. The design of each of these tubes is completely new, incorporating many recent advances in klystron technology.

A large Eimac Matrix Type A cathode is used in the 4KM50SK with cathode current loading of less than 200 milliamperes per square centimeter. This light cathode loading, for an S-band klystron, assures long life. The electron gun has a confined flow configuration which minimizes focusing adjustments and produces a very stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting rf output or body current. Only one electromagnet power supply is required.

Four integral cavities are used in the 4KM50SK. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc which will withstand severe abuse. This window is protected by a photo cell arc detector which must be connected so that a wave guide arc will remove beam voltage or drive power.

The 4KM50SK incorporates a built-in vacuum pump in the form of a titanium getter which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the Eimac Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-161, has been designed for use with the 4KM50SK.

Eimac Water Load WL-202 is recommended for use with the 4KM50SK.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - - - -	7.5	volts
	Current - - - - -	12	amperes
	Maximum Starting Current - -	24	amperes
Cathode:	EMA, Unipotential		
	Heating time - - - -	5	minutes
Getter	(Operating):		
	Voltage (±5%) - - - -	4	volts ac
	Current - - - - -	20	amperes ac
Power Gain	- - - - -	40	decibels
Output Power	- - - - -	10	kilowatts
Frequency Range	- - -	2550 to 2700	megacycles

(Effective 5-2-63)

MECHANICAL

Operating Position		Any
Coupling (rf)		
Input		Type N coaxial fitting
Output		UG435A/U flange
Maximum Dimensions (4KM50SK and H-161 Electromagnet)		
Diameter	18	inches
Length	35	inches
Weight:		
Klystron Only	90	lbs
H-161 Electromagnet	170	lbs
Cooling:		
Water and Forced Air		
	Flow Rate	Pressure Drop
Cathode	5 cfm	free
Klystron Body (water)	1.2 gpm	30 psi
Collector (water)	18 gpm	30 psi
Electromagnet (water)	1.5 gpm	15 psi
Klystron Body (Ethylene Glycol solution)*	1.2 gpm	38 psi
Collector (Ethylene Glycol solution)*	23 gpm	38 psi
Electromagnet (Ethylene Glycol solution)*	2 gpm	30 psi

*60% Ethylene Glycol, 40% water

ELECTRO MAGNET POWER-SUPPLY REQUIREMENTS

Voltage	0 to 150	volts
Current	0 to 15	amperes

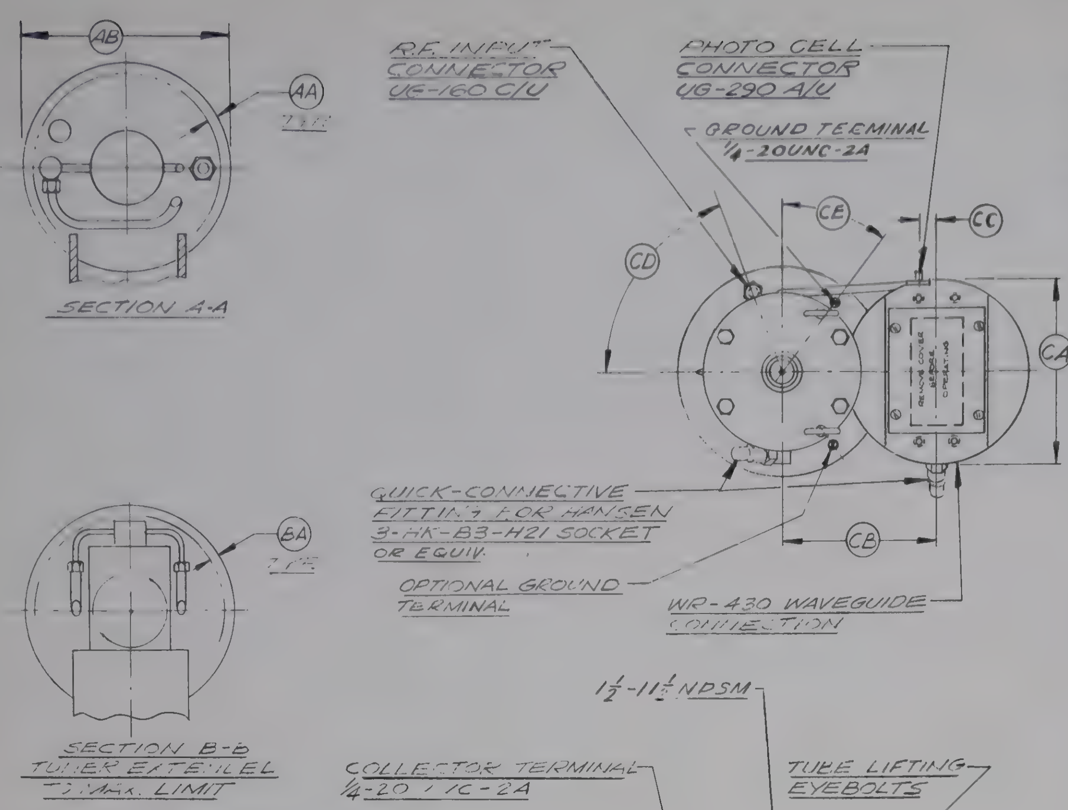
MAXIMUM RATINGS

BEAM VOLTAGE	20	kilovolts dc
BEAM CURRENT	3	amperes dc
BEAM INPUT POWER	50	kilowatts dc
BODY CURRENT	100	milliamperes dc
COLLECTOR DISSIPATION	50	kilowatts
INLET WATER PRESSURE	80	psi
COOLANT OUTLET TEMPERATURE	70	degrees C

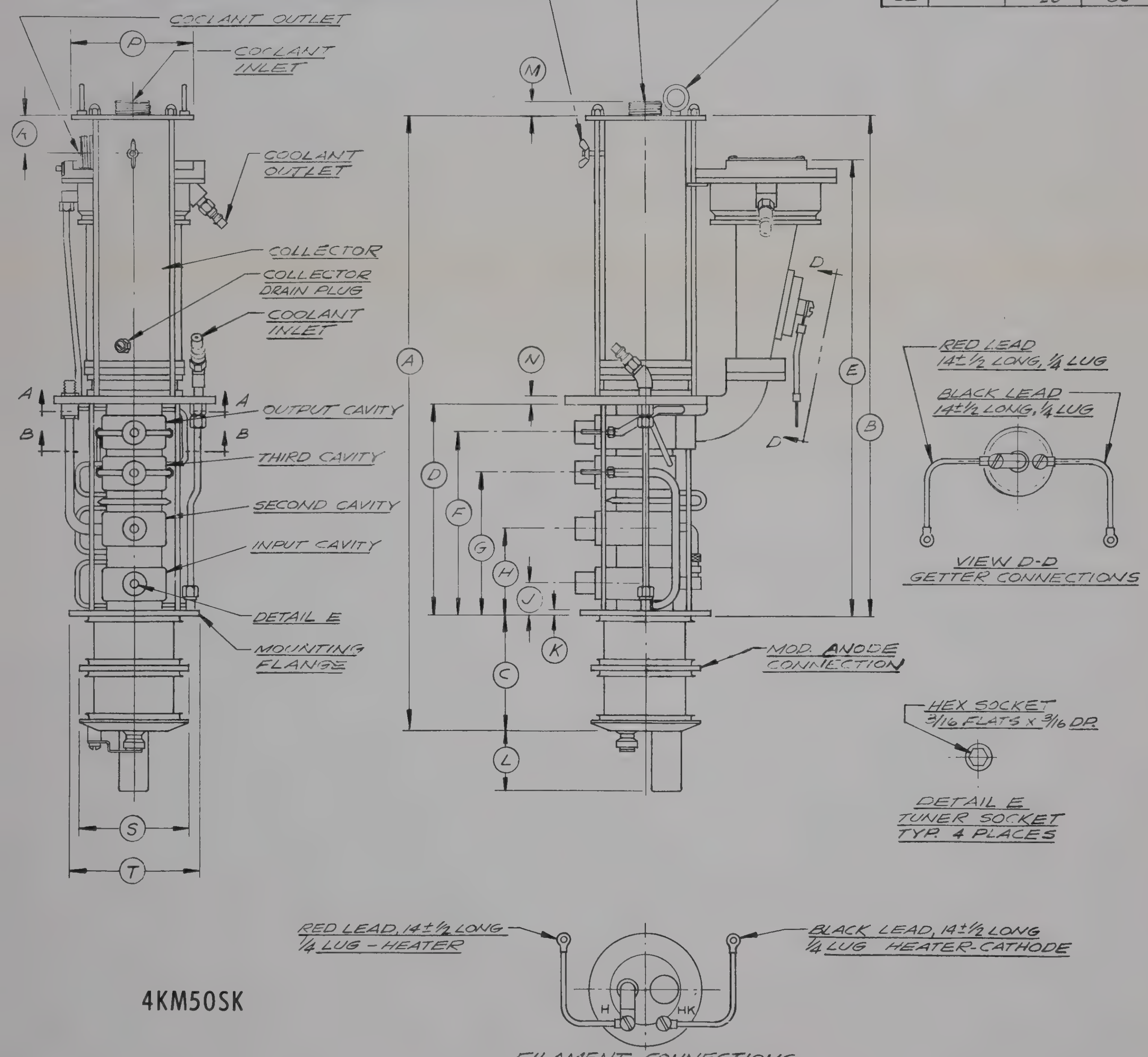
TYPICAL OPERATION

	Tuned For Maximum Efficiency		Stagger Tuned For Greater Bandwidth		
Frequency	2550	2700	2550	2700	megacycles
Output Power	13.2	12.1	10.2	10.1	kilowatts
Driving Power	1	1	1	1	watt
Power Gain	41.2	40.7	40.1	40	decibels
Beam Voltage	18	18	18	18	kilovolts
Beam Current	1.8	1.8	1.8	1.8	amperes
Modulating Anode Voltage	10.4	10.4	10.4	10.4	kilovolts
Beam Power Efficiency	40.8	37.5	31.7	31.2	percent
Body Current	45	45	55	55	milliamperes
3db Bandwidth	11	11	14	14	megacycles
Electromagnet Current	12.5	12.5	12.5	12.5	amperes

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.



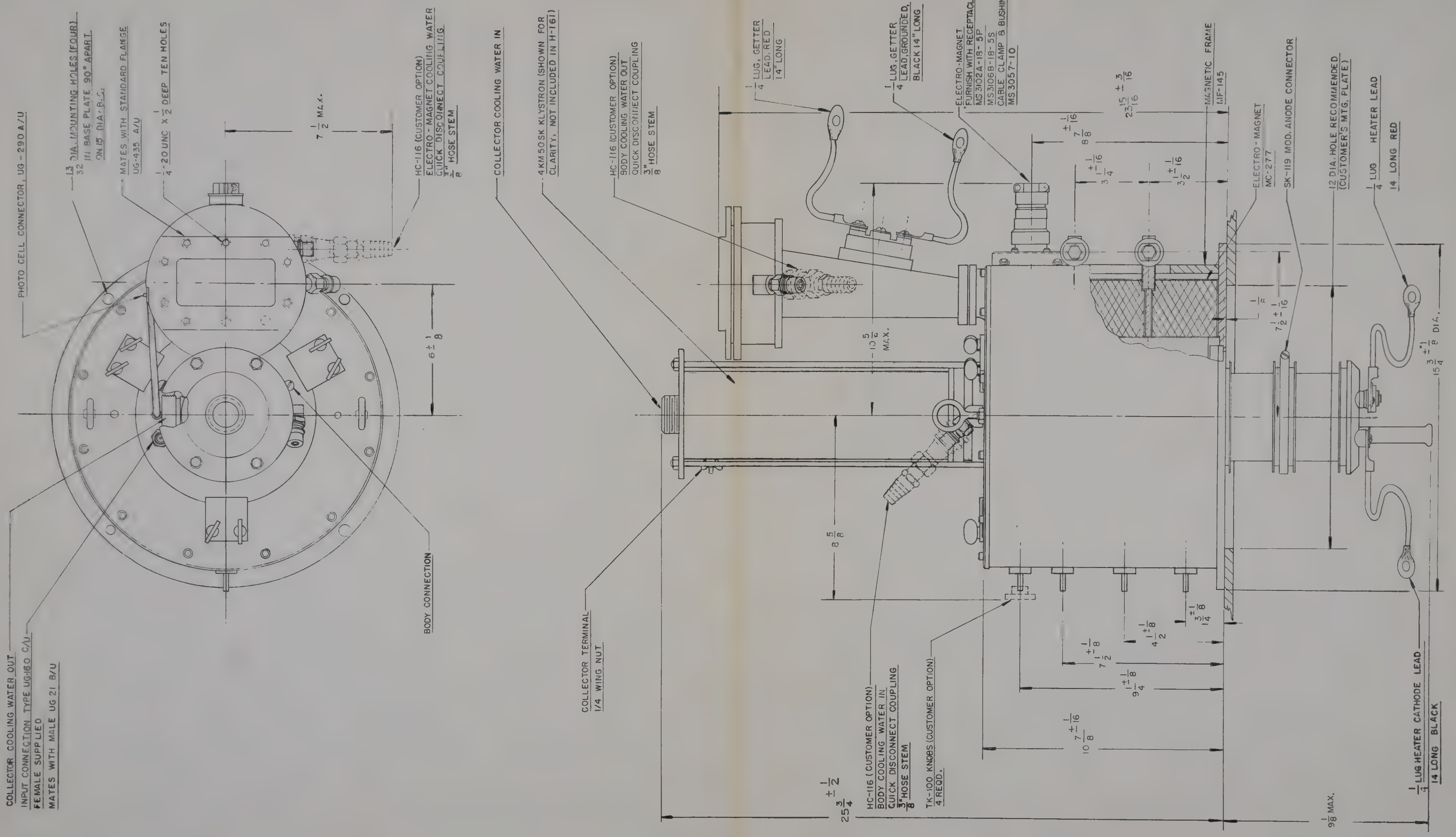
DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A	30.366		
B	24.670		
C	5.696		
D		10.325	10.525
E		23.600	24.000
F	9.125		
G	7.375		
H	4.388		
J	1.638		
K		.230	.270
L			3.250
M			1.000
N		.345	.405
P		5.950	6.050
R		1.470	1.720
S			5.280
T		6.490	6.500
AA		.437	
AB		7.990	8.000
BA		.380	
CA		6.970	7.030
CB		5.750	6.250
CC		.510	.610
CD		65°	75°
CE		20°	30°



4KM50SK

4KM50SK

H-161 CIRCUIT ASSEMBLY



Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM100LA 25KW

POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM100LA is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 470 to 610 megacycles. Intended primarily for television visual service, it is also suitable for aural TV, or for tropospheric-scatter communications service.

In television visual service the 4KM100LA will provide more than 25 kilowatts of peak synchronizing power, with a power gain of 30 decibels, and 1db bandwidth of 8 megacycles. Random AM noise is more than 60db below black level.

The electron gun of this klystron utilizes a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. The cathode loading of only 100 milliamperes per square centimeter, at a beam voltage of 18 kilovolts, is ultra conservative in the interest of long life. Effective protection from internal arcs is provided by the Eimac Modulating Anode.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. Load couplers are provided to permit external loading of these cavities for extreme wideband operation.

The 4KM100LA incorporates a built-in vacuum pump in the form of a titanium getter. This getter should be energized whenever heater power is applied. Its normal operating voltage is 3.7 volts at approximately 20 amperes.

Eimac Klystron Amplifier Circuit Assembly H-163 has been designed for use with the 4KM100LA to cover the specified frequency range. This assembly includes a klystron supporting structure, focusing electromagnet, tuning cavities, and adjustable load couplers for each cavity.

CHARACTERISTICS

ELECTRICAL

Heater:	DC Voltage	26.0	volts
	DC Current	11.5	amperes
	Maximum Starting Current	23	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	AC Voltage (±5%)	3.7	volts
	AC Current	20	amperes
Power Gain:			
	Television Visual Service	30	decibels
Output Power:			
	Television Visual Service	25	kilowatts
Frequency Range (H-163 Assembly)		470 to 610	megacycles

MECHANICAL

Maximum Height of Klystron and H-163 Assembly including KC-102 Carriage	67 inches
Operating Position	Axis vertical, cathode up
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3-1/8 inch, 50-ohm line
Input and 2nd Cavity Loading	Type "N" coaxial fitting
3rd Cavity Loading	1-5/8 inch, 50-ohm line
Weights:	
Klystron Only	119 pounds
H-163 RF Circuit Assembly	1800 pounds
Cooling: Water and Forced Air	

	Flow Rate	Pressure Drop
Cathode	*5 cfm	-------
Cavity	50 cfm	TBS
Klystron Body and Electromagnet in Series	2 gpm	45 psi
Klystron Collector	30 gpm	7.5 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	0 to 150	volts
Current	0 to 12	amperes

MAXIMUM RATINGS

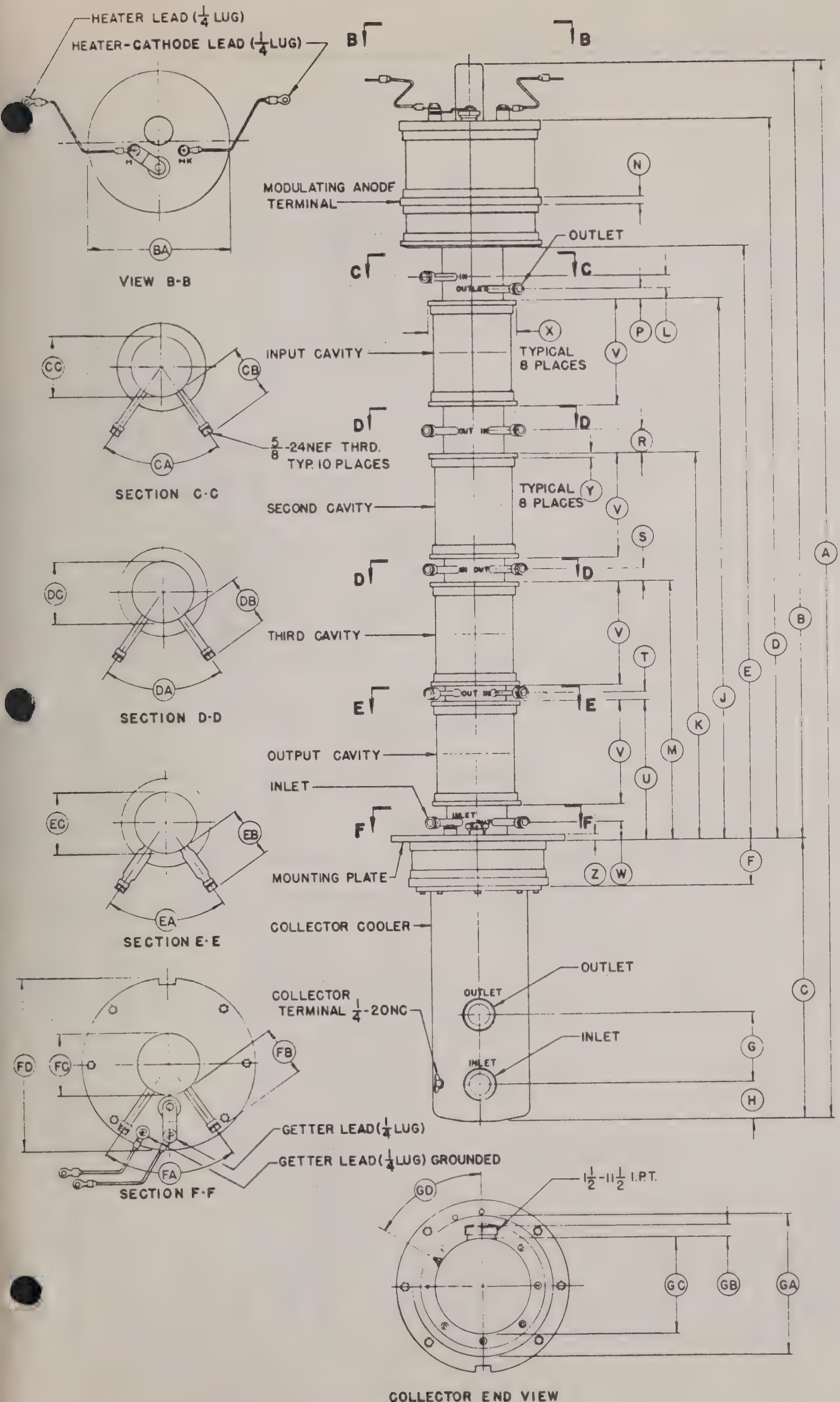
DC BEAM VOLTAGE	20	KILOVOLTS
DC BEAM CURRENT	6.0	AMPERES
DC BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	100	KILOWATTS
INLET WATER PRESSURE	100	PSI

TYPICAL OPERATION

	TV Visual Amplifier	
Frequency	550	megacycles
Output Power	26.4 (peak sync.)	kilowatts
Driving Power	20 " "	watts
Power Gain	31 " "	decibels
DC Beam Voltage	16	kilovolts
DC Beam Current	3.82	amperes
Beam Power Efficiency	43 (peak sync.)	percent
1 db Bandwidth	8	megacycles
Electromagnet Current	8.9	amperes

* Required only if ambient air temperature exceeds 25° C.

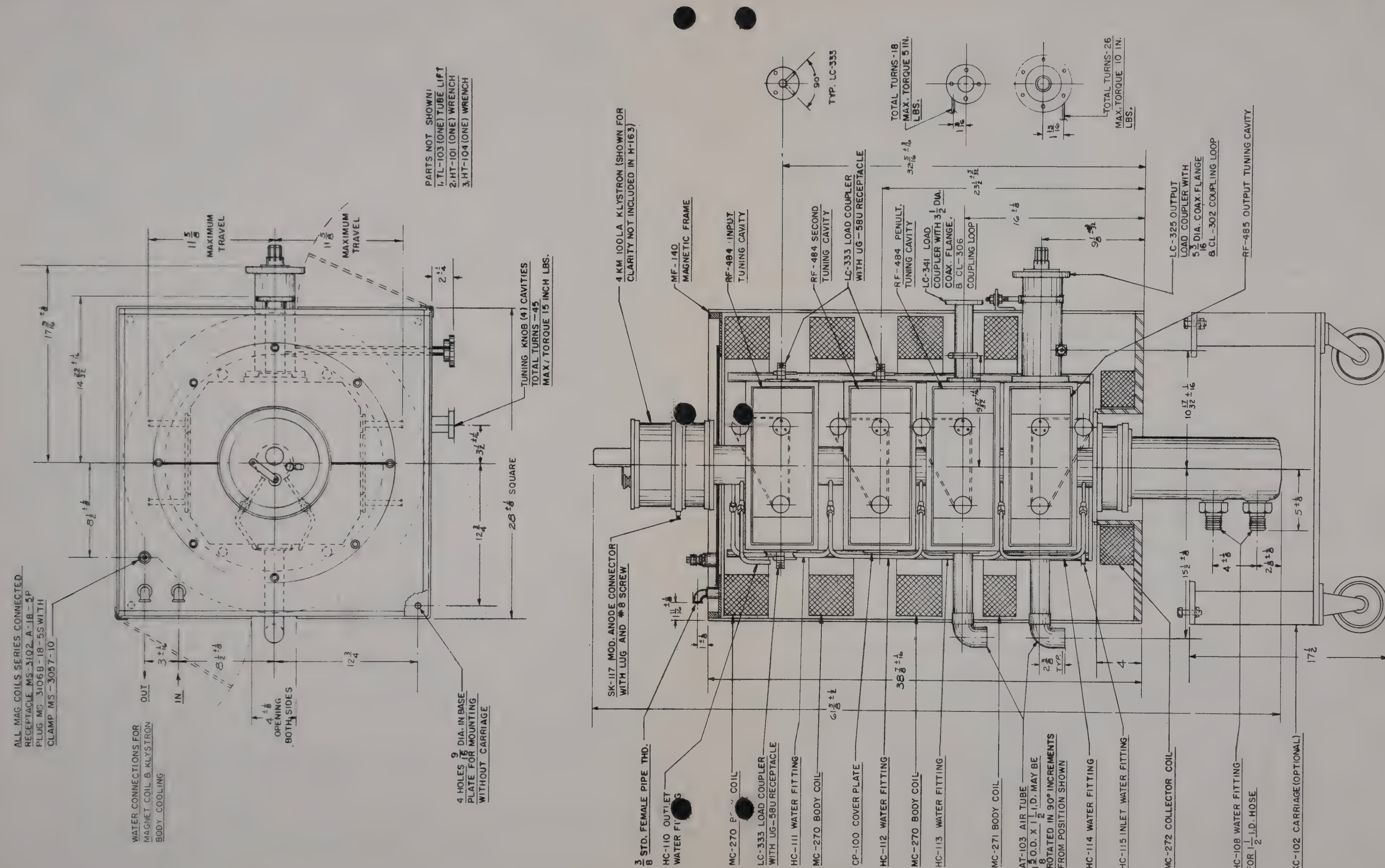
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.



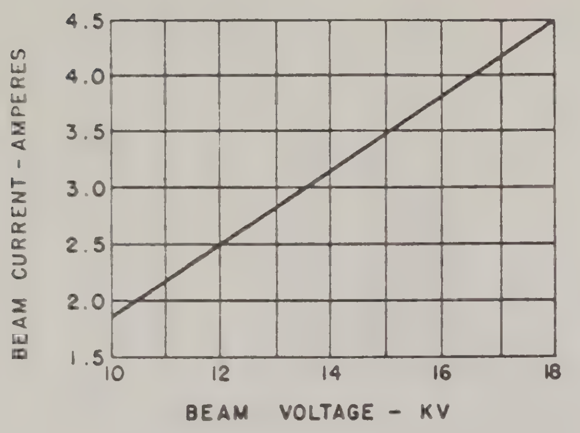
DIMENSION DATA			
REF.	NOMINAL	MINIMUM	MAXIMUM
A	61.625		
B	45.150		
C	16.475		
D	41.900		
E	34.487		
F	2.600		
G	4.000		
H	2.125		
J	31.341		
K	22.499		
L	.625		
M	14.999		
N	.375		
P	.636		
R	1.433		
S	.875		
T	.453		
U	8.124		
V	6.000		
W	1.124		
X	5.125		
Y	.250		
Z	.375		
BA	8.125 DIA		
CA	70°		
CB	3.000		
CC	3.500 DIA		
DA	70°		
DB	3.000		
DC	3.500 DIA		
EA	70°		
EB	3.000		
EC	3.500 DIA		
FA	70°		
FB	3.000		
FC	3.500 DIA		
FD	10.000 DIA		
GA	8.125 DIA		
GB	.843		
GC	5.500 DIA		
GD	60°		

4KM100LA KLYSTRON

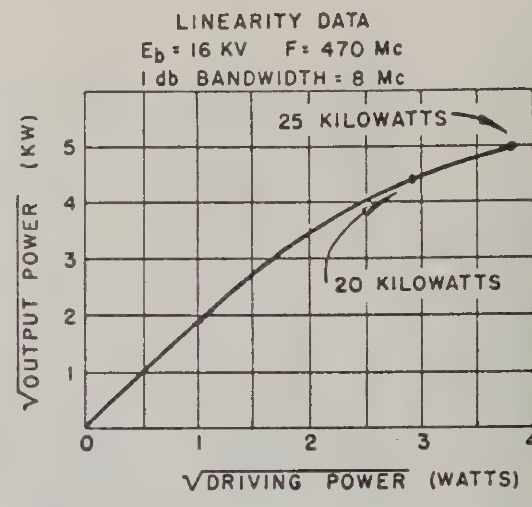
4KM100LA



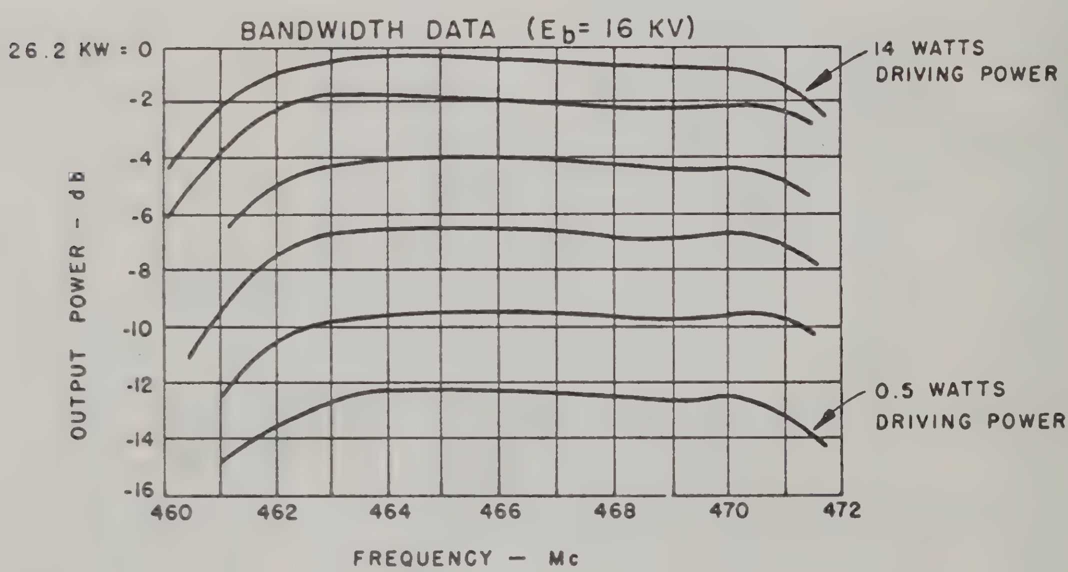
H-163 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY



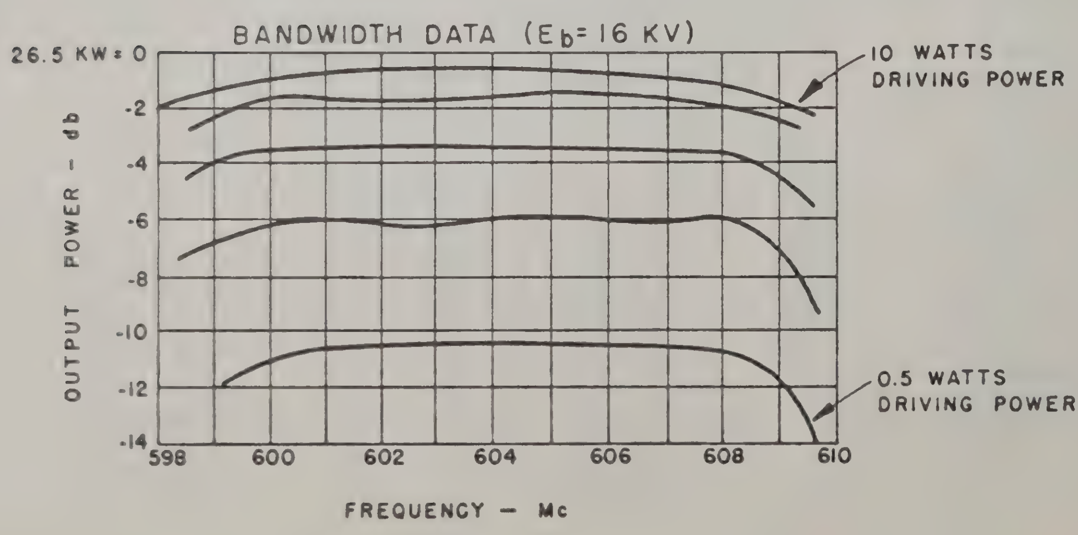
BEAM CURRENT - AMPERES
4.5
4.0
3.5
3.0
2.5
2.0
1.5
10
12
14
16
18
BEAM VOLTAGE - KV



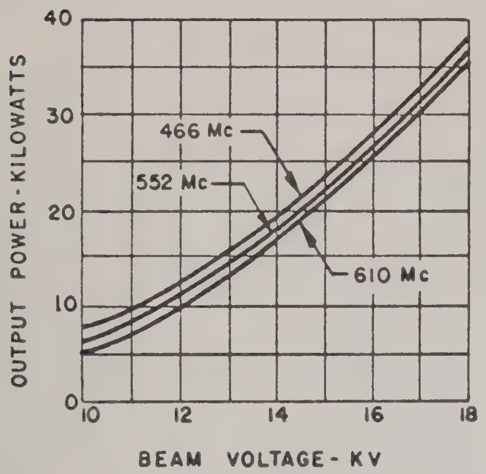
LINEARITY DATA
Eb = 16 KV F = 470 Mc
1 db BANDWIDTH = 8 Mc
√OUTPUT POWER (KW)
25 KILOWATTS
20 KILOWATTS
√DRIVING POWER (WATTS)

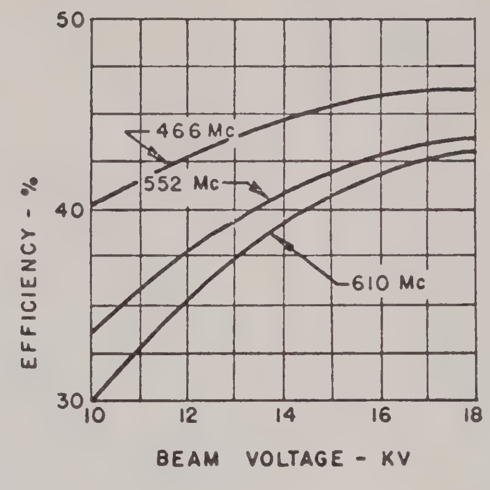


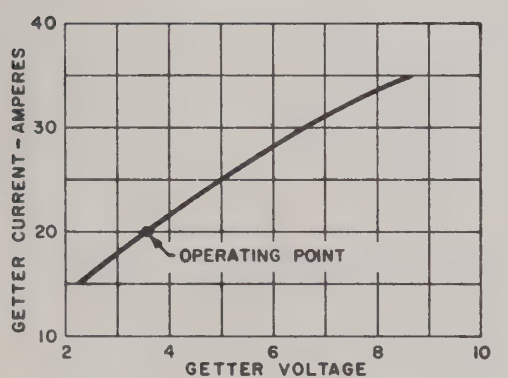
BANDWIDTH DATA (Eb= 16 KV)
26.2 KW = 0
14 WATTS DRIVING POWER
0.5 WATTS DRIVING POWER
OUTPUT POWER - db
FREQUENCY — Mc

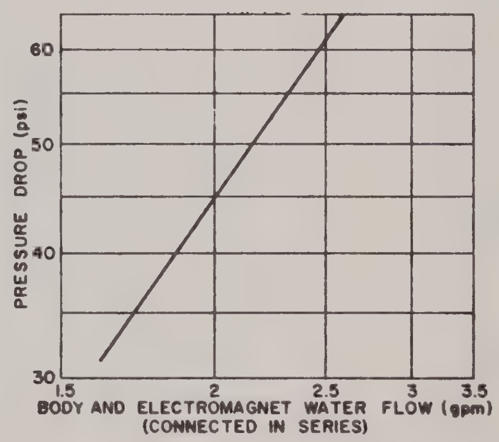


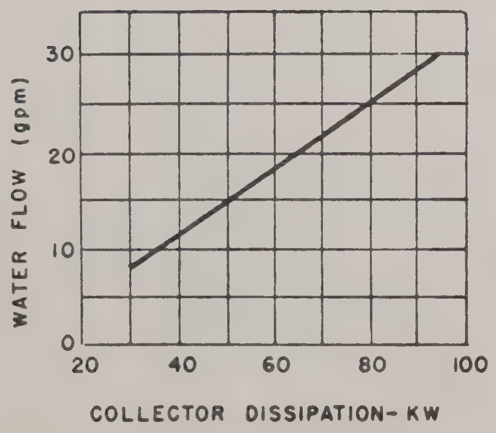
BANDWIDTH DATA (Eb= 16 KV)
26.5 KW = 0
10 WATTS DRIVING POWER
0.5 WATTS DRIVING POWER
OUTPUT POWER - db
FREQUENCY — Mc

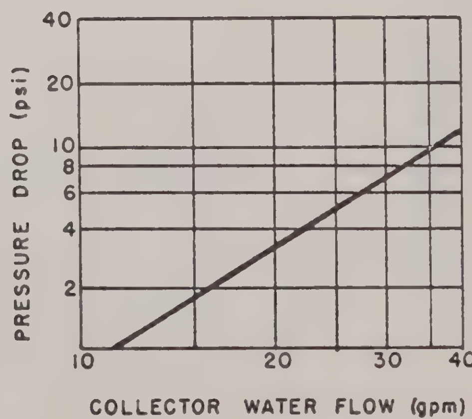

OUTPUT POWER - KILOWATTS
466 Mc
552 Mc
610 Mc
BEAM VOLTAGE - KV


EFFICIENCY - %
466 Mc
552 Mc
610 Mc
BEAM VOLTAGE - KV


GETTER CURRENT - AMPERES
OPERATING POINT
GETTER VOLTAGE


PRESSURE DROP (psi)
BODY AND ELECTROMAGNET WATER FLOW (gpm)
(CONNECTED IN SERIES)


WATER FLOW (gpm)
COLLECTOR DISSIPATION - KW

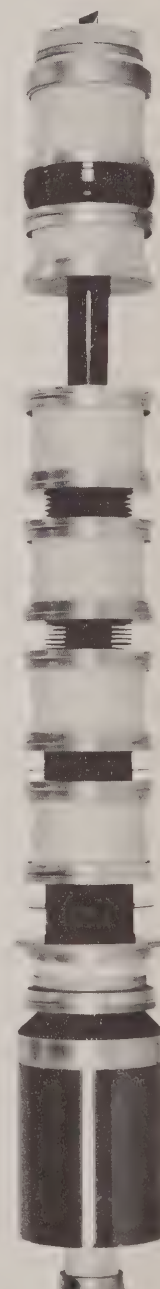

PRESSURE DROP (psi)
COLLECTOR WATER FLOW (gpm)

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

TENTATIVE DATA

4KM3000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM3000LQ is a four-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 710 and 985 megacycles and will deliver a minimum CW output power of two kilowatts with a minimum power gain of 25 decibels when operated at 50% collector depression.

The collector is designed to operate at less than the cathode to anode voltage, thereby realizing an improvement in efficiency.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 4KM3000LQ are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals,

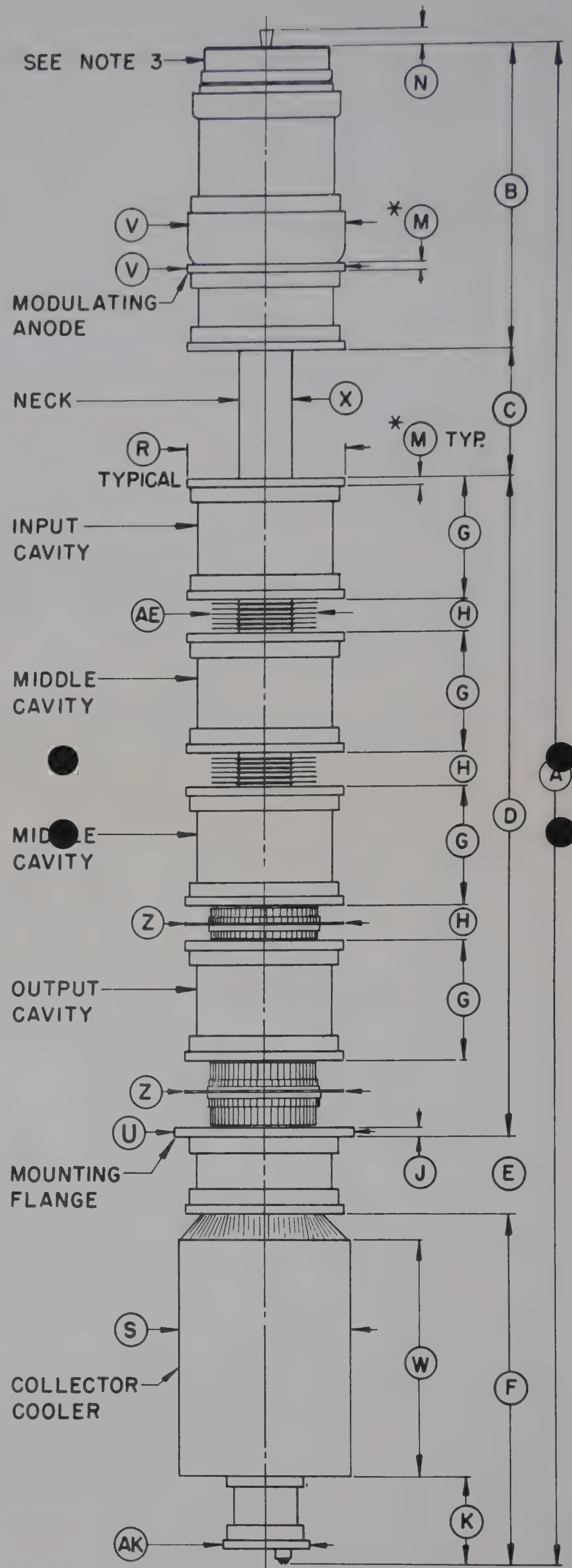
Eimac Klystron Amplifier Circuit Assembly H-118, for use with the 4KM3000LQ, covers the frequency range of 710 to 985 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, output r-f load coupler and an Eimac SK-100 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

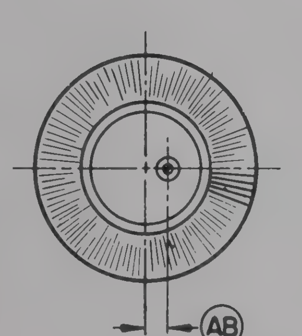
Cathode, Unipotential, Oxide Coated		
Minimum Heating Time - - -	5	minutes
Heater: Voltage - - -	5	volts
Current - - -	33	amperes
Maximum Starting Current -	65	amperes
Modulating Anode Capacitance (To other electrodes) - - -	21	uuf
Power Gain (Narrow Band CW) - -	25	decibels
Output Power (Narrow Band CW) -	2000	watts
Frequency Range (In H-118 Circuit Assembly) -	710 to 985	megacycles

DIMENSIONS			
REF.	NOM.	MIN.	MAX.
A	44.187		
B	8.781		
C	3.750		
D	19.250		
E	2.125		
F	10.265		
G	3.500		
H	1.000		
J	.250		
K	2.578		
M		.187	
N		.650	1.000
R	4.625 DIA.		
S	5.135 DIA.		
U	5.375 DIA.		
V	4.625 DIA.		
W	6.937		
X	1.500 DIA.		
Z	4.625 DIA		
AB	.500		
AE	3.078 DIA.		
AK	2.500 DIA.		



NOTES

1. *MINUMUM CONTACT SURFACE.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. I OUTLINE, DRWG. NO. GUN NO. I – 6001.



COLLECTOR COOLER
END VIEW

4KM3000LQ OUTLINE DRAWING

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling	
Input	Type "N" coaxial fitting
Output	1-5/8 inch 50-ohm line
Shipping Weights:	
Klystron Only	49 lbs (Net); 138 lbs (Gross)
H-118 R-F Amplifier Circuit Assembly	327 lbs (Net); 473 lbs (Gross)

Cooling:

The 4KM3000LQ is cooled by forced air. At sea level and with inlet air temperature of 20°C (68°F) the flow rates tabulated below are sufficient for operation at maximum ratings and at maximum collector depression of 50%.

Cathode (with SK-100 Air-System Socket)	5 cfm
Penultimate Cavity	50 cfm
Output Cavity	75 cfm
Collector	150 cfm

Operation at higher altitudes or with higher inlet temperatures requires increased volumes of air flow to obtain equivalent cooling.

MAGNETIC-COIL POWER SUPPLY-REQUIREMENTS

Prefocus Coil Voltage	0 to 50	volts
Prefocus Coil Current	2.0	amperes
Each of Three Body Coils		
Voltage	0 to 100	volts
Current	3.0	amperes
Collector Coil Voltage	0 to 50	volts
Collector Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	10,000	VOLTS
D-C BEAM CURRENT	0.750	AMPERE
D-C FOCUS ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	3000	WATTS
SEAL TEMPERATURES	175	DEGREES C

TYPICAL OPERATION - NARROW BAND CW AMPLIFIER - COLLECTOR DEPRESSED

Frequency	900	megacycles
Output Power	2150	watts
Driving Power	4.0	watts
Power Gain	27	decibels
D-C Beam Voltage	9000	volts
D-C Beam Current	0.580	amperes
D-C Collector Voltage (from Cathode)	4500	volts
D-C Collector Current	0.210	amperes
D-C Body Current	0.370	amperes
Focus Electrode Voltage	-200	volts
Efficiency	50.0	percent

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

Printed in U.S.A. 890

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM50,000LA3

POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM50,000LA3 is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 400 to 610 megacycles. It is suitable for use in UHF television visual service and may also be used for FM, for aural TV, or for tropospheric-scatter communications service.

When adjusted for narrow-band CW operation this klystron will deliver a minimum output power of 10 kilowatts with a power gain of 50 decibels. In television visual service it will provide more than 10 kilowatts of peak synchronizing power with a power gain of 30 decibels. The random AM noise is more than 50 decibels below black level.

The 4KM50,000LA3 employs the Eimac Modulating Anode which provides an effective means of protecting the tube from internal arcs when connected to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-143 has been designed for use with the 4KM50,000LA3 to cover the specific frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for the second, third and output cavities and an Eimac SK-110 Air System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - - -	7.5	volts
	Current - - - -	40.0	amperes
	Maximum Starting Current -	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time - - -	5	minutes
Getter (Operating):			
	Voltage - - - -	2.0	volts
	Current - - - -	36.0	amperes
Power Gain: (Narrow Band) - -		50	decibels
Output Power - - - - -		10	kilowatts
Frequency Range (H-143 Assembly)		400 to 610	megacycles

MECHANICAL

Operating Position - - - - - -	Axis vertical, cathode up
R-F Coupling:	
Input - - - - - - -	Type "N" coaxial fitting
Output - - - - - - -	3 1/8 inch, 50-ohm line
Input Cavity Loading - - - - -	Type "N" coaxial fitting
2nd and 3rd Cavity Loading - - - -	1 5/8 inch, 50-ohm line

MECHANICAL (cont'd)

Weights:

4KM50,000LA3 Klystron only	- - - -	64 lbs (Net)
	- - - -	155 lbs (Gross)
H-143 RF Circuit Assembly	- - - -	767 lbs (Net)
	- - - -	1084 lbs (Gross)

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity - - -	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series) - - -	1 gpm	28 psi
Klystron Collector - - - -	25 gpm	28 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil:	Voltage	- - - - -	0 to 50	volts
	Current	- - - - -	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:				
	Voltage	- - - - -	0 to 500	volts
	Current	- - - - -	0 to 2.5	amperes

MAXIMUM RATINGS

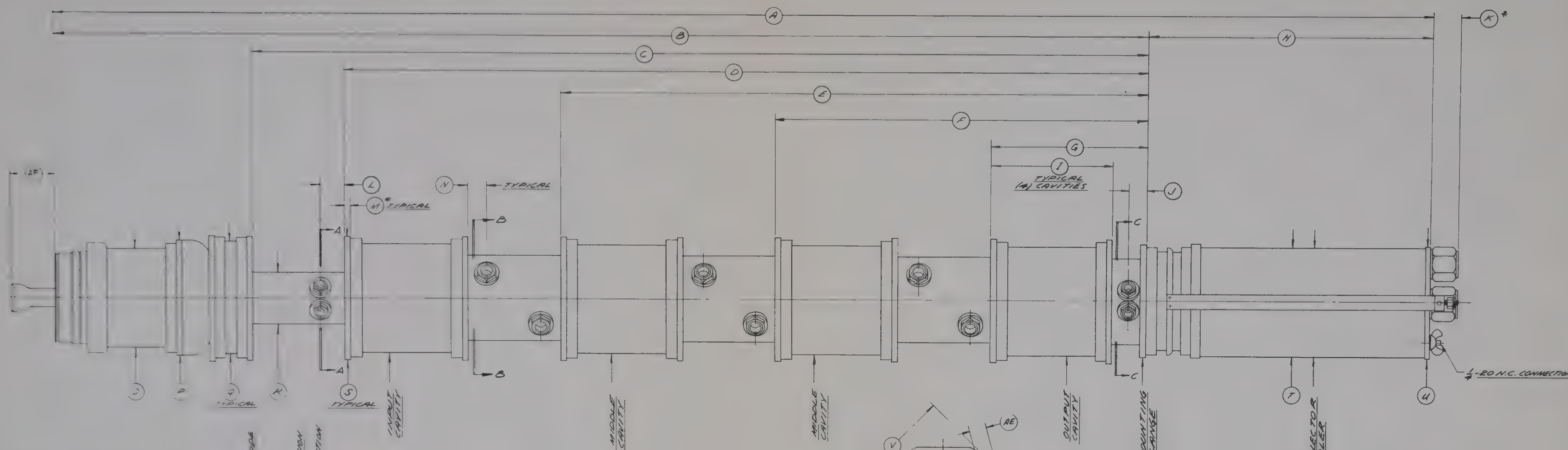
D-C BEAM VOLTAGE	- - - - -	20	KILOVOLTS
D-C BEAM CURRENT	- - - - -	2.5	AMPERES
D-C BODY CURRENT (CONTINUOUS)	- - -	100	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	- - -	150	MILLIAMPERES
A-C GETTER CURRENT	- - - - -	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	- - - -	-500	VOLTS
COLLECTOR DISSIPATION	- - - - -	50	KILOWATTS
INLET WATER PRESSURE	- - - - -	50	PSI

TYPICAL OPERATION, NARROW BAND, CW AMPLIFIER

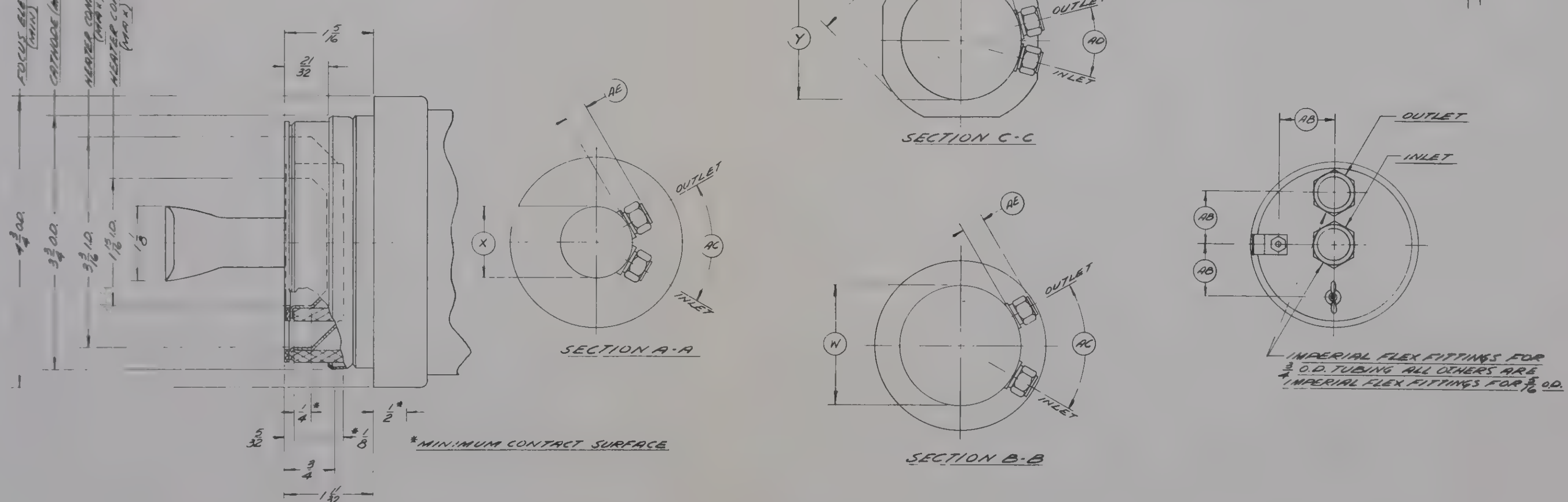
Frequency	- - - -	400	610	megacycles
Output Power	- - - -	13.1	12.0	kilowatts
Driving Power	- - - -	.050	.050	watt
Power Gain	- - - -	54	53.8	decibels
D-C Beam Voltage	- - - -	17	17	kilovolts
D-C Beam Current	- - - -	1.8	1.8	amperes
Beam Power Efficiency	- - - -	42.8	39.2	percent
D-C Body Current	- - - -	90	80	milliamperes
D-C Collector Current	- - - -	1.71	1.72	amperes
Focus-Electrode Voltage		-201	-211	volts
Magnetic-Coil Currents (H-143 Components):				
Prefocus Coil	- - - -	1.0	0.97	ampere
Three Body Coils and Collector Coil in Series		2.0	2.0	amperes

* At Sea level with 20° C inlet air temperature.

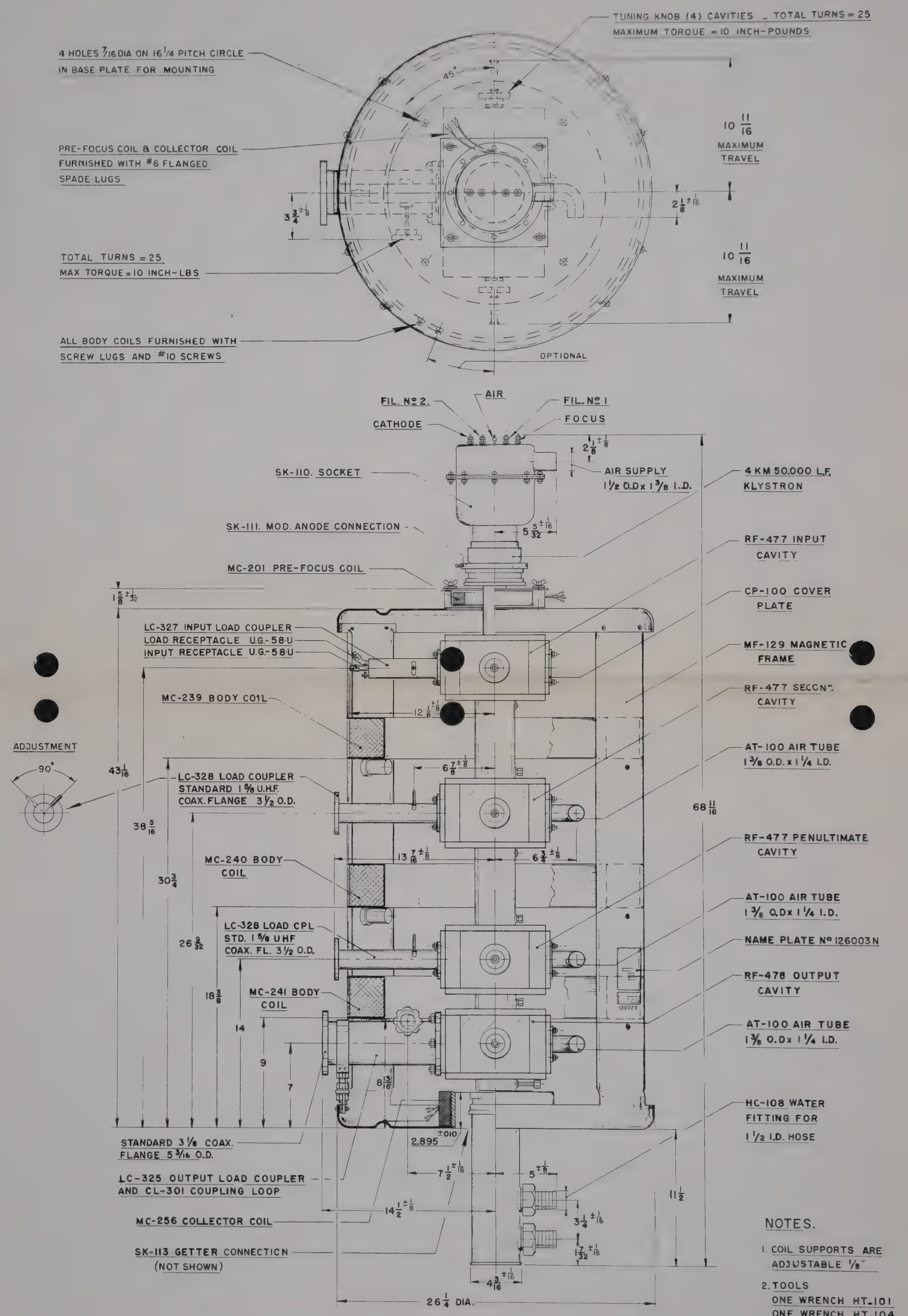
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California



DIMENSION DATA			
NO	NOM.	MIN.	MAX.
A		61.125.	61.635.
B		49.695.	50.065
C		41.788	42.038
D		37.990	38.210
E		27.824	27.984
F		17.652	17.762
G		7.485	7.535
H		[illegible]	[illegible]
I		5.995.	6.025
J		.335	.469
K		1.000	1.150
L		[illegible]	[illegible]
M		.245	.255
N		.832	[illegible]
O		3.998	[illegible]
P		4.615	[illegible]
Q		4.498	4.502
R		2.115	2.125
S		5.120	5.130
T		[illegible]	4.505
U		4.610	4.640
V		5.120	5.130
W		3.495	3.505
X		2.115	2.125
Y		3.415	3.505
AB		1.610	1.640
AC		50°	70°
AD		20°	40°
AE		.837	[illegible]
AF			1.750



4KM50,000LA3 KLYSTRON



H-139 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM50,000LF

POWER AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM50,000LF is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 610 to 790 megacycles. Although intended primarily for UHF television visual service this klystron may also be used for FM, for aural TV, or for tropospheric-scatter communications service.

When tuned for narrow band CW operation this klystron will deliver a minimum output power of 10 kilowatts with a power gain of 45 db. In television visual service it will provide more than 10 kilowatts of peak synchronizing output power with a power gain of 30 db. The AM random noise is more than 50 db below black level. Minimum bandwidth at the 3 db power level is 8 megacycles with a minimum of 7 megacycles at the 1 db level.

The 4KM50,000LF employs the Eimac Modulating Anode which provides an effective means of protecting the tube from internal arcs.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits a wide tuning range and allows external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-139 has been designed for use with the 4KM50,000LF to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for the second, third and output cavities and an Eimac SK-110 Air System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - - -	7.5	volts
	Current - - - -	40.0	amperes
	Maximum Starting Current - -	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time - - - -	5	minutes
Getter (Operating):			
	Voltage - - - -	2.0	volts
	Current - - - -	36.0	amperes
Power Gain:	Narrow Band - - -	45	decibels
	Television Visual Service -	30	decibels
Output Power:	Television Visual Service -	10	kilowatts
Frequency Range (H-139 Assembly)		610 to 790	megacycles

MECHANICAL

Operating Position - - - - -	Axis vertical, cathode up
R-F Coupling:	
Input - - - - -	Type "N" coaxial fitting
Output - - - - -	3 1/8 inch, 50-ohm line
Input Cavity Loading - - - - -	Type "N" coaxial fitting
2nd and 3rd Cavity Loading - - - -	1 5/8 inch, 50-ohm line

MECHANICAL (cont'd)

Shipping Weights:

4KM50,000LF Klystron only	64	pounds
H-139 RF Circuit Assembly	767	pounds

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series)	1 gpm	28 psi
Klystron Collector	(See collector cooling curves)	

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil: Voltage	0 to 50	volts
Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:		
Voltage	0 to 500	volts
Current	0 to 2.5	amperes

MAXIMUM RATINGS

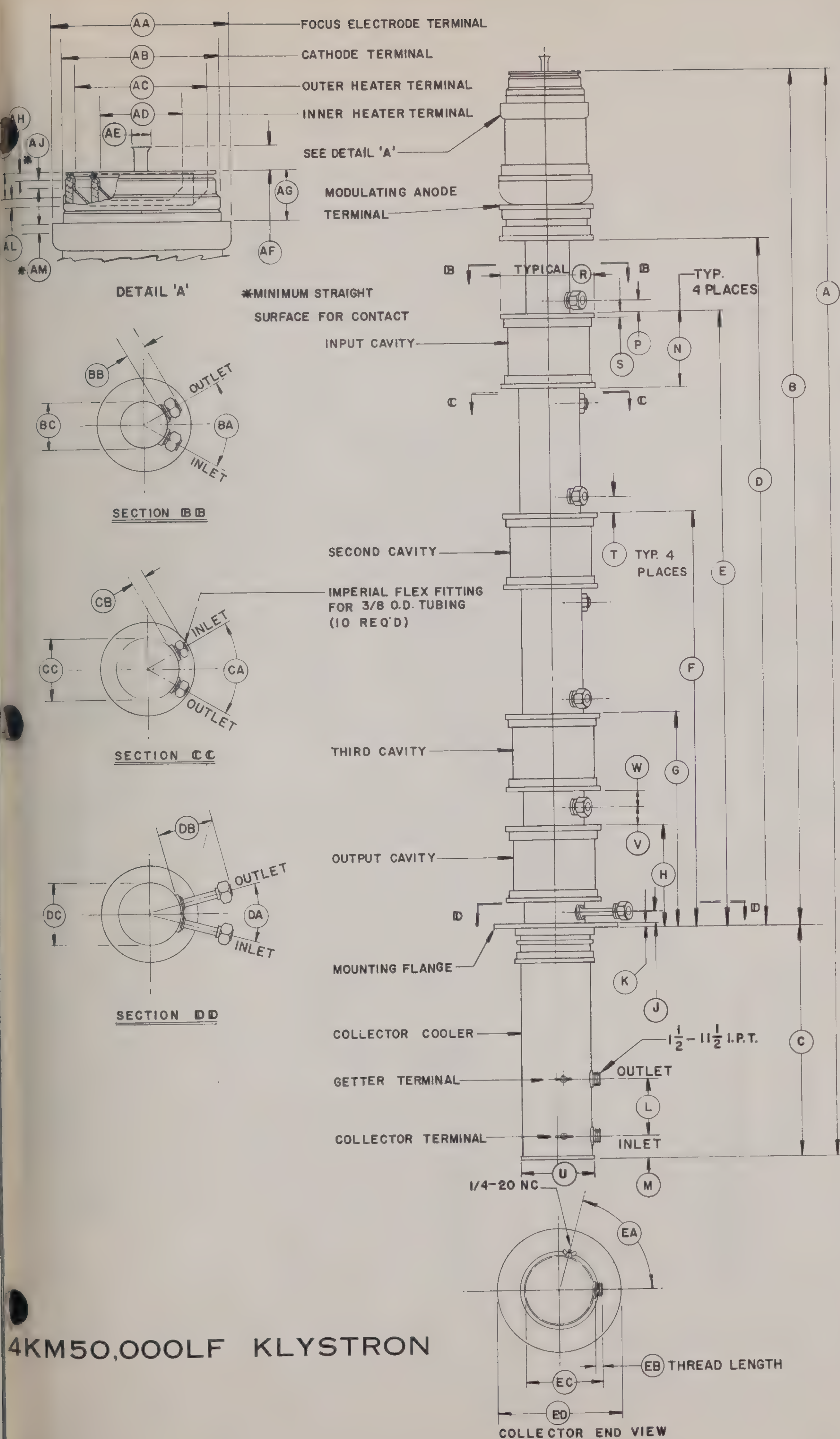
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	2.5	AMPERES
D-C BODY CURRENT	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	60	KILOWATTS
INLET WATER PRESSURE	50	PSI

TYPICAL OPERATION

	TV Visual Service	Narrow Band	
Frequency	610	735	megacycles
Output Power	12.6	15.6	kilowatts
Driving Power	10	0.30	watts
Power Gain	30.3	47.2	decibels
D-C Beam Voltage	18	18	kilovolts
D-C Beam Current	2.03	2.03	amperes
Beam Power Efficiency	34.5	43	percent
D-C Body Current	75	45	milliamperes
Focus-Electrode Voltage	-200	-200	volts
Cavity Loading:			
1st Cavity	0.47	--	watts
2nd Cavity	116	--	watts
3rd Cavity	390	--	watts
Magnetic-Coil Currents:			
Prefocus Coil	1.15	1.15	amperes
Three Body Coils and Collector Coil in Series	2.3	2.3	amperes

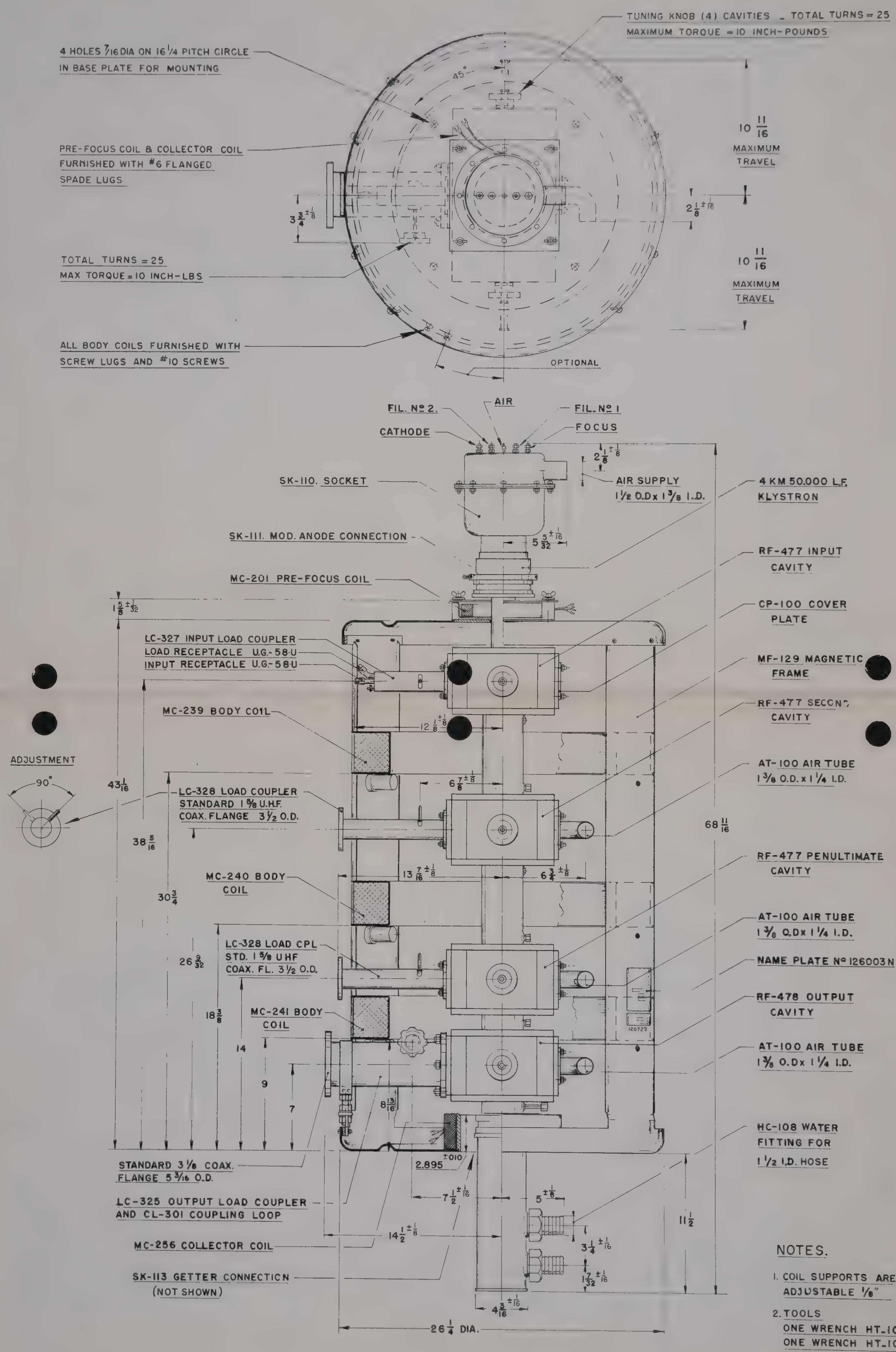
* At sea level with 20° C inlet air temperature.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.



4KM50,000LF KLYSTRON

	DIMENSION DATA		
ITEM	NOM.	MIN.	MAX.
A		63.700	65.200
B		49,600	50.300
C		14.250	14.750
D		41.600	42.100
E		37.800	38.325
F		25.600	26.000
G		13.400	13.700
H		6.490	6.650
J		0.400	0.500
K		0.335	0.365
L		3.200	3.300
M		1.100	1.300
N		4.950	5.040
P		0.840	1.100
R		5.105	5.145
S		0.230	0.270
T		0,840	
U		4.165	4.215
V		0.840	
W		0.840	
AA		4.300 DIA.	4.450 DIA
AB		3.750 "	3.835 "
AC		3.100 "	3.200 "
AD		1.865 "	1.950 "
AE			1.188
AF			1.750
AG		1.000	1.500
AH		.125	.175
AJ		.100	
AK		.670	.775
AL		.100	
AM		.500	
BA		55°	65°
BB		0.800	1.000
BC		2.100	2.140
CA		55°	65°
CB		0.800	1.000
CC		3.480	3.520
DA		25°	35°
DB		2.430	2.630
DC		3.480	3.520
EA		75°	85°
EB		0.600	
EC		4.875	5.125
ED		7.140	7.165



NOTES.

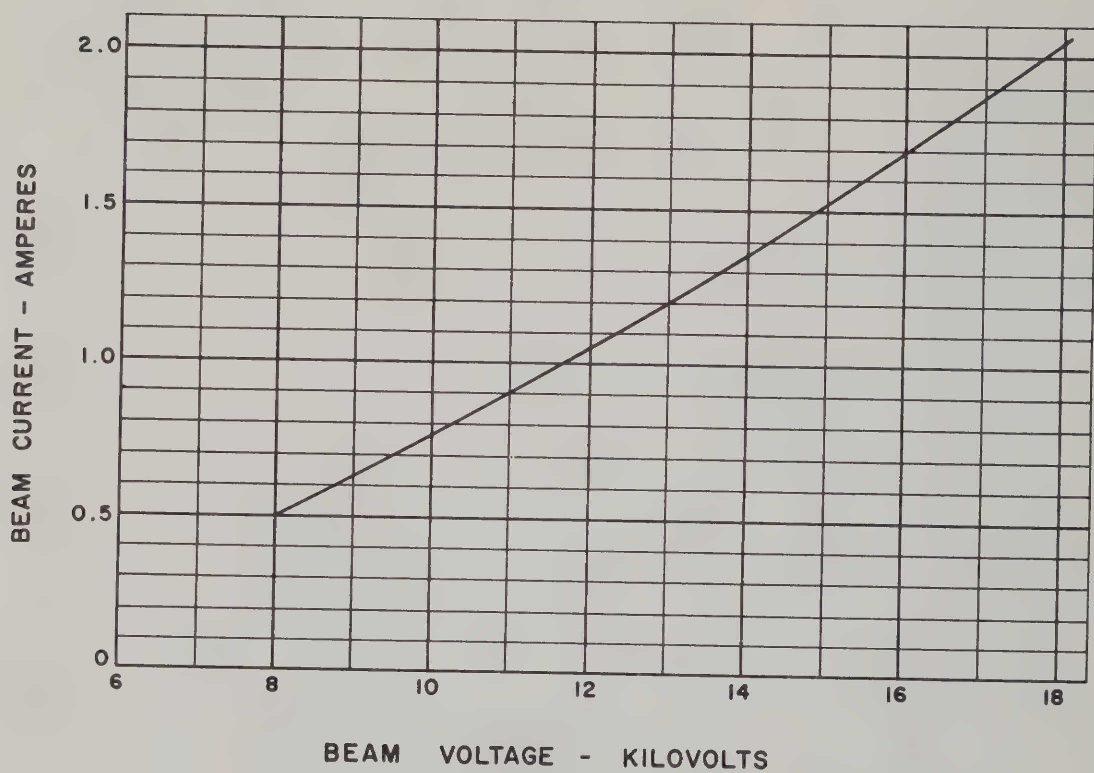
1. COIL SUPPORTS ARE ADJUSTABLE 1/8"
2. TOOLS
   ONE WRENCH HT-101
   ONE WRENCH HT-104

H-139 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EIMAC 4KM50,000LF

BEAM VOLTAGE vs BEAM CURRENT

E_{foc} = -200 VOLTS



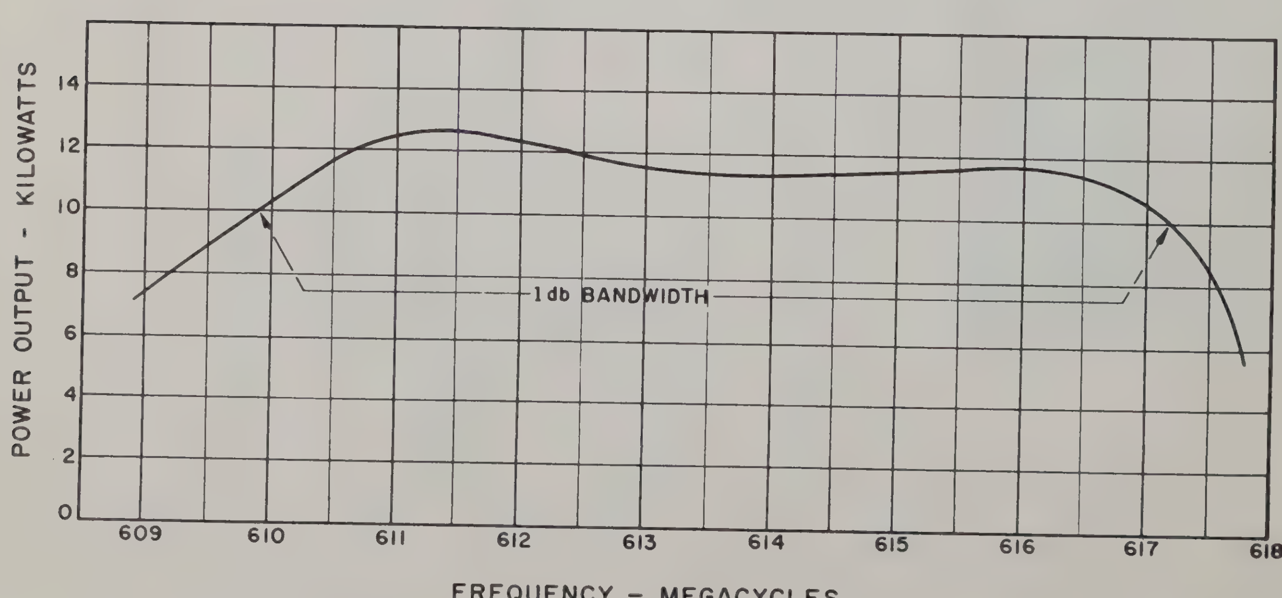
EIMAC 4KM50,000LF

BANDWIDTH DATA

E_b = 18 KILOVOLTS

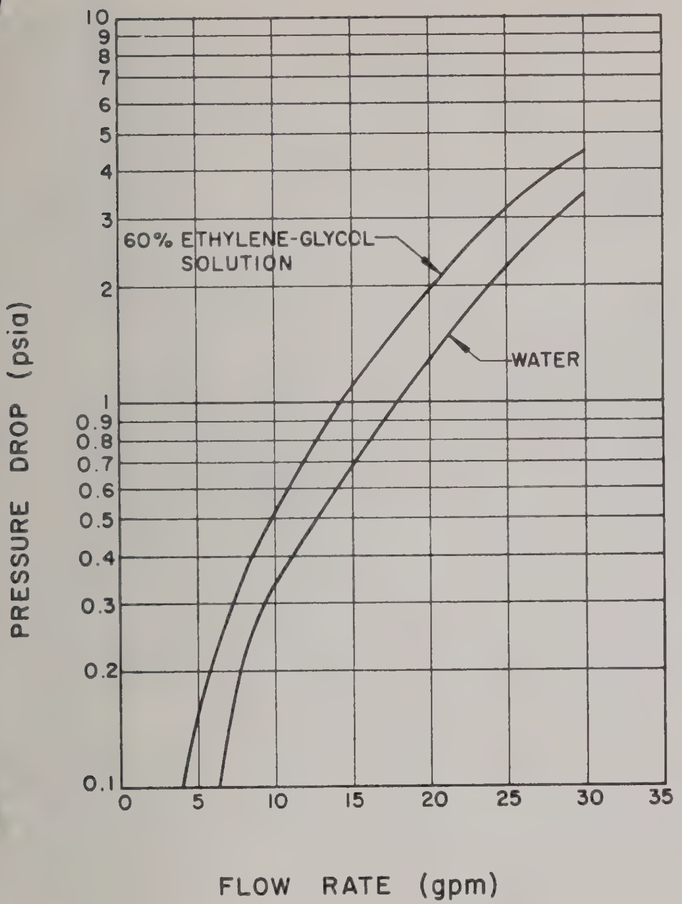
I_b = 2.03 AMPERES

P_D = 10 WATTS



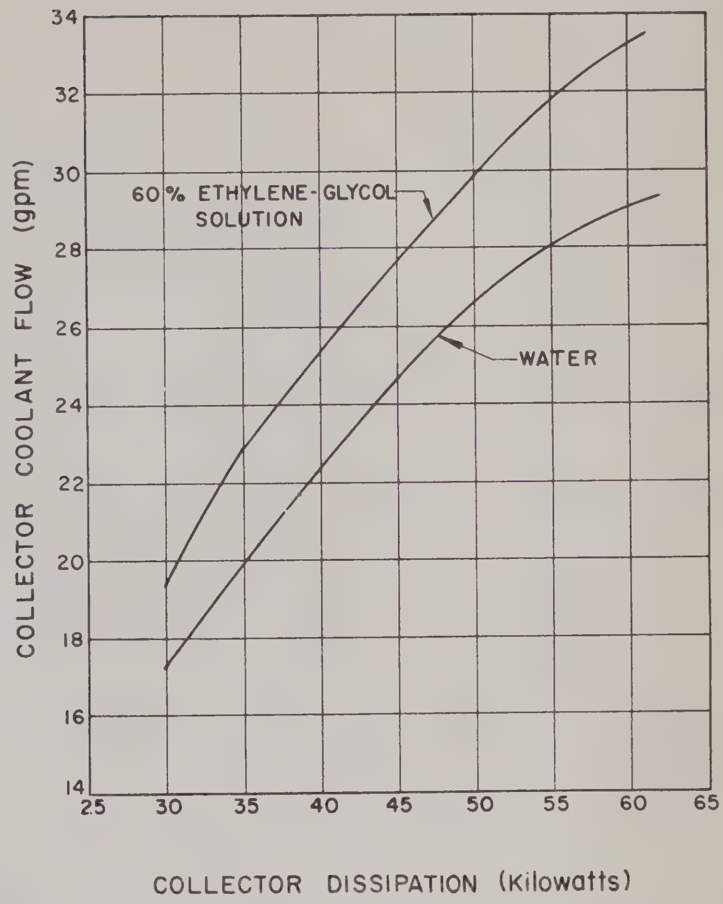
EIMAC 4KM50,000LF

PRESSURE DROP vs COOLANT FLOW RATE
ACROSS COLLECTOR



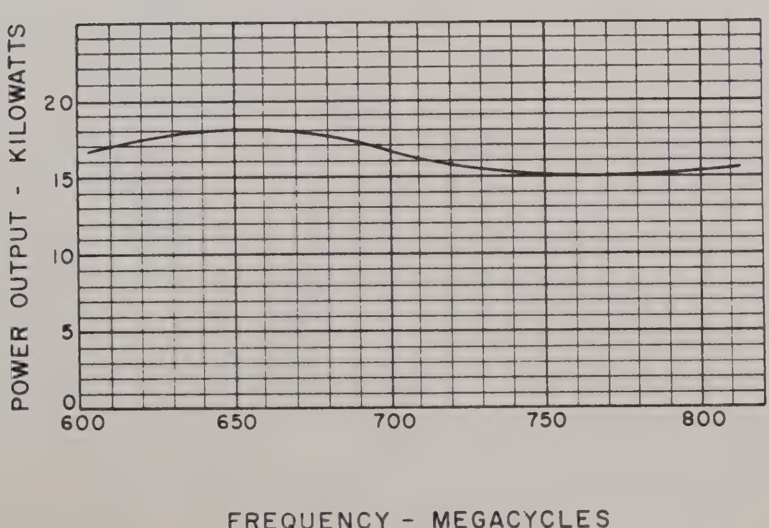
EIMAC 4KM50,000LF

COLLECTOR DISSIPATION vs COOLANT FLOW
COOLANT INLET TEMPERATURE 25°C



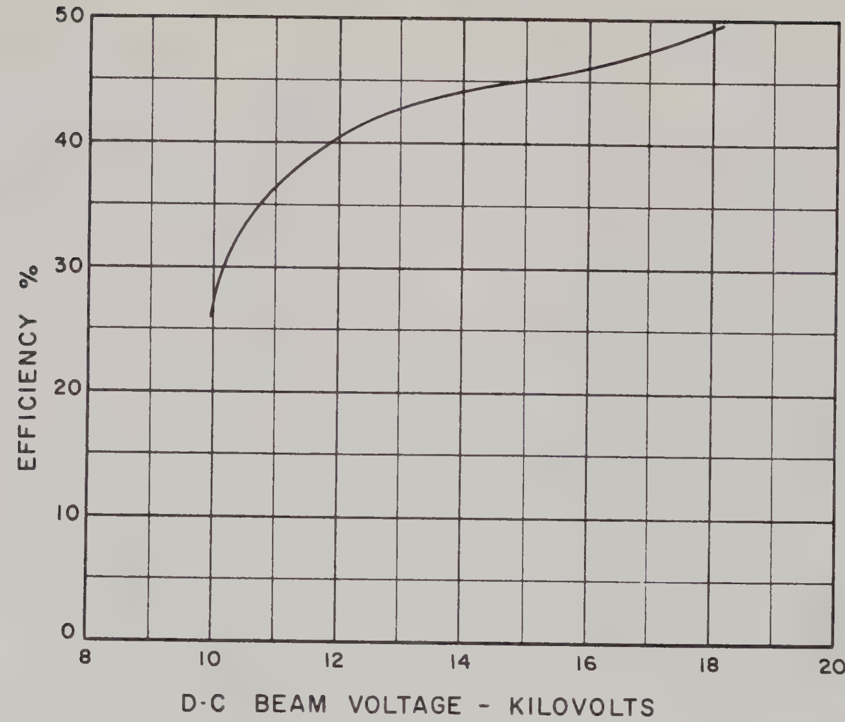
EIMAC 4KM50,000LF

POWER OUTPUT vs FREQUENCY
NARROW BAND
I_b = 2.03 AMPERES
P_d = 0.3 WATTS
E_{foc} = -200 VOLTS
E_b = 18 KILOVOLTS



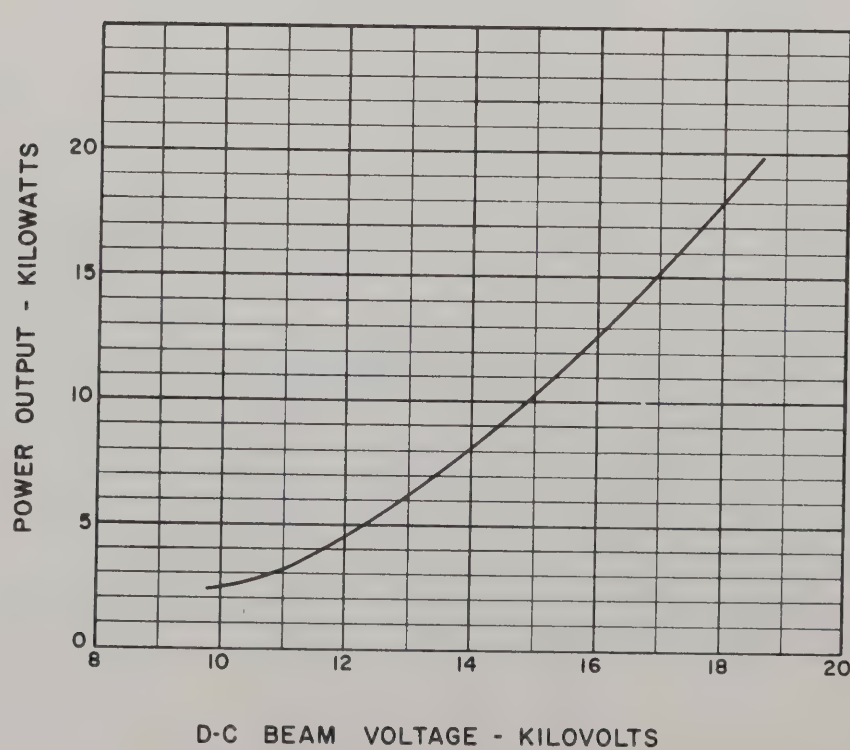
EIMAC 4KM50,000LF

EFFICIENCY vs BEAM VOLTAGE
NARROW BAND
FREQUENCY = 700 MEGACYCLES



EIMAC 4KM50,000LF

POWER OUTPUT vs BEAM VOLTAGE
NARROW BAND
FREQUENCY = 700 MEGACYCLES

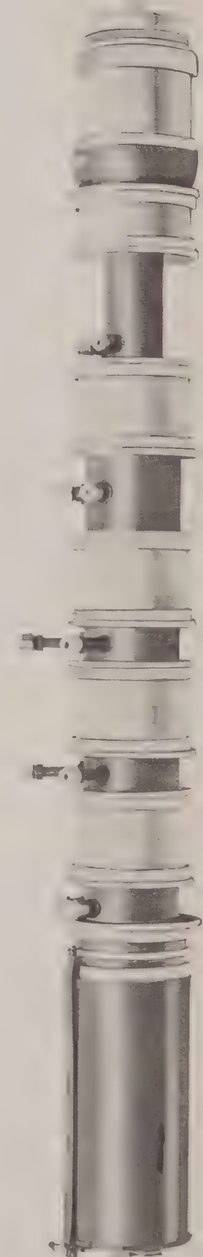


EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM50,000LR

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM50,000LR is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 755 and 985 megacycles. This klystron will deliver a narrow-band CW output power of 10 kilowatts with a minimum power gain of 50 decibels. When adjusted for wide-band operation the 4KM50,000LR will deliver an output power of 10 kilowatts with a half-power bandwidth of 7 megacycles and a power gain of 30 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means for protecting the tube against internal arcs when connected to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-141 has been designed for use with the 4KM50,000LR to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for each cavity, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7.5	volts
	Current	40.0	amperes
	Maximum Starting Current	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter	(Operating) :		
	Voltage	2.0	volts
	Current	36.0	amperes
Power Gain: (Narrow Band)		50	decibels
Output Power		10	kilowatts
Frequency Range (H-141 Assembly)		755 to 985	megacycles

MECHANICAL

Operating Position		Axis vertical, cathode up
RF Coupling:		
	Input	Type "N" coaxial fitting
	Output	3 1/8 inch, 50-ohm line
	Input Cavity Loading	Type "N" coaxial fitting
	2nd and 3rd Cavity Loading	Type "N" coaxial fitting

MECHANICAL (cont'd)

Weights:

4KM50,000LR Klystron only	55 lbs (Net), 140 lbs (Gross)
H-141 RF Circuit Assembly	349 lbs (Net), 601 lbs (Gross)

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections in series)	1 gpm	28 psi
Klystron Collector	25 gpm	28 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 25	volts
	Current	0 to 1.25	amperes
Three Body Coils and Collector Coil in Series:	Voltage	0 to 400	volts
	Current	0 to 4.0	amperes

MAXIMUM RATINGS

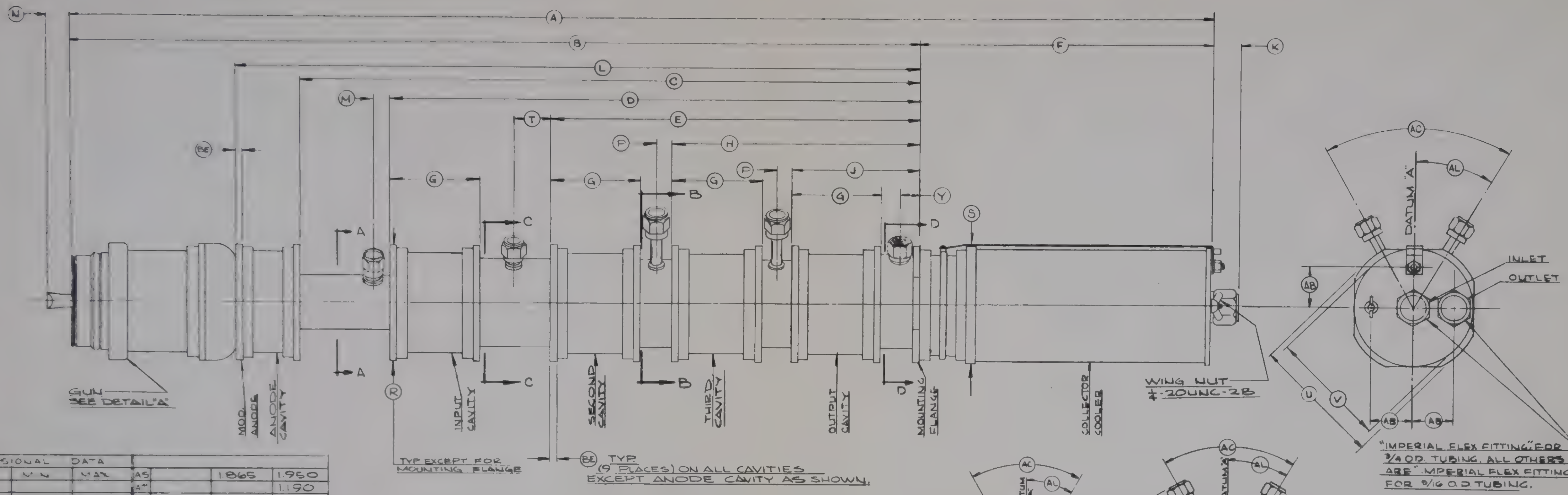
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	2.5	AMPERES
D-C BODY CURRENT (CONTINUOUS)	100	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS
INLET WATER PRESSURE	50	PSI

TYPICAL OPERATION

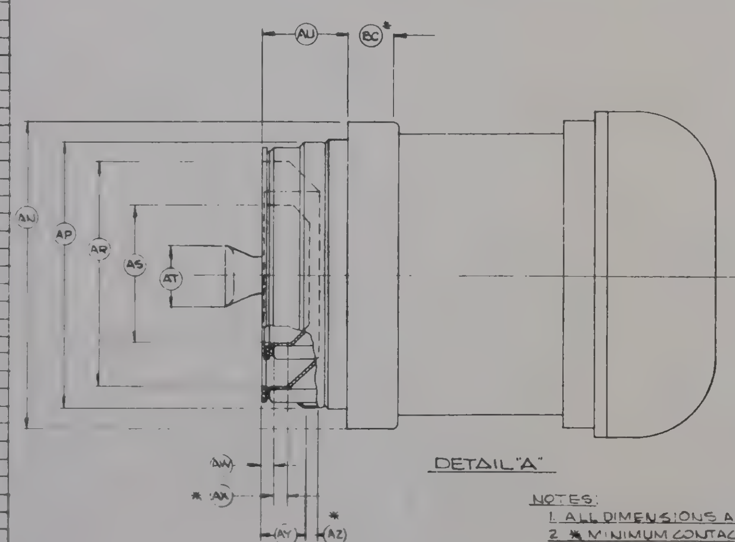
	Narrow Band		Wide Band	
Frequency	755	985	762	megacycles
Output Power	12.1	11.5	10	kilowatts
Driving Power	0.05	0.05	10	watts
Power Gain	53.8	53.6	30	decibels
D-C Beam Voltage	17	17	17	kilovolts
D-C Beam Current	1.76	1.76	1.9	amperes
Beam Power Efficiency	45.7	43.7	31	percent
D-C Body Current	30	40	90	milliamperes
Focus-Electrode Voltage	-245	-245	-175	volts
Half Power Bandwidth	- -	- -	7	megacycles
Cavity Loading:				
1st Cavity	- -	- -	8	watts
2nd Cavity	- -	- -	70	watts
3rd Cavity	- -	- -	400	watts
Magnetic-Coil Currents:				
Prefocus Coil	1.06	1.03	1.1	amperes
Three Body Coils and Collector Coil in Series	3.0	3.0	3.0	amperes

* At sea level with 20° C inlet air temperature.

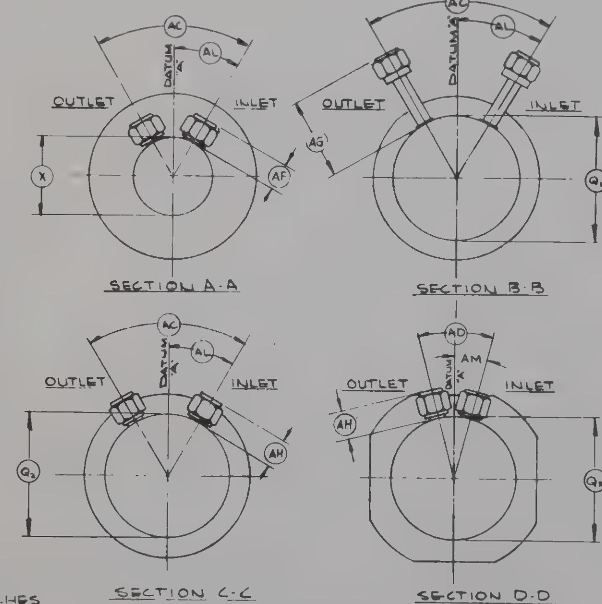
For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.



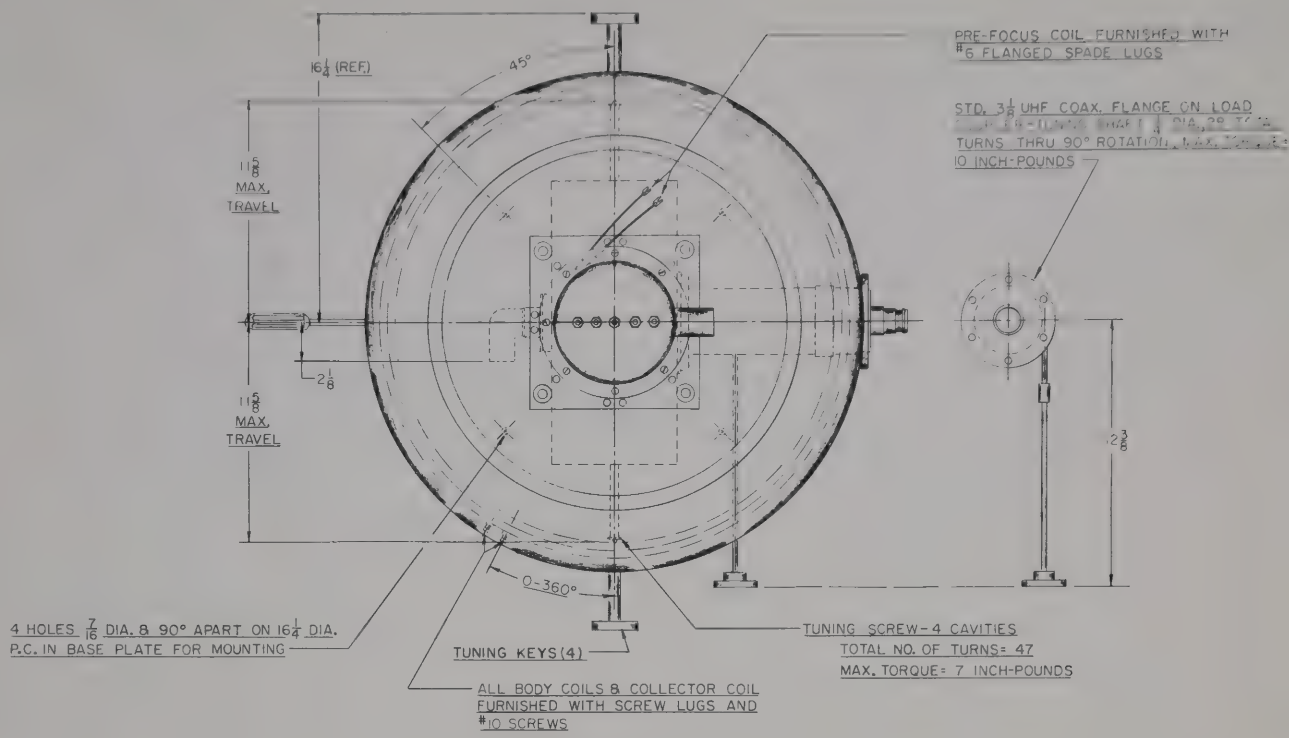
DIMENSIONAL DATA							
No.	NOM	MIN	MAX	AS		1.865	1.950
A	44.040			AT			1.190
B	33.27			AU		1.000	1.500
C	24.392			AV			
D	20.642			AW		.125	.175
E	14.388			AX		.100	
F	11.818			AY		.670	.775
G	3.504			AZ		.100	
H	9.696			BA			
J	5.004			BC		.100	
K	1.062			BD			
L	26.875			BE	0.250		
M	.562						
N			1.750				
P	.593						
Q	3.500						
R	4.625	4.610	4.640				
S	4.720						
T	1.375						
U	3.122						
V	4.625						
W							
X	2.180						
Y	0.636						
AB	.5/8						
AC	60°						
AD	30°						
AE							
AF	.850						
AG	2.250						
AH	0.850						
AJ							
AK							
AL	30°						
AM	15°						
AN		4.300	4.450				
AP		3.750	3.835				
AQ							
AR		3.100	3.200				

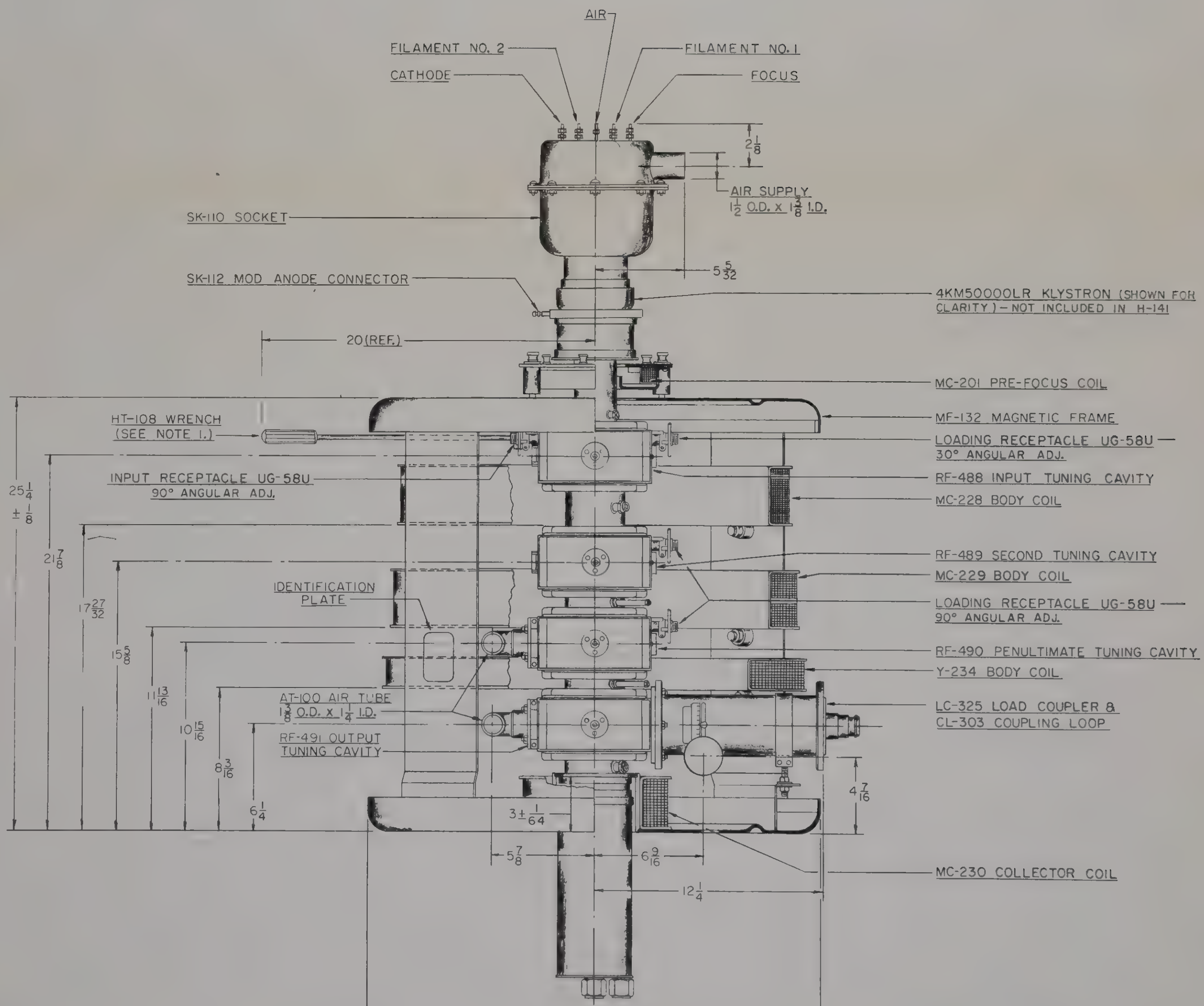


NOTES:
1. ALL DIMENSIONS ARE IN INCHES
2. * MINIMUM CONTACT SURFACE



4KM50,000LR KLYSTRON





NOTES

1. ONE HT-108 WRENCH SUPPLIED FOR ADJUSTING ALL RECEPTACLE LOOPS

PARTS NOT SHOWN

HT-101 WRENCH (FOR CAVITIES)

H-141 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

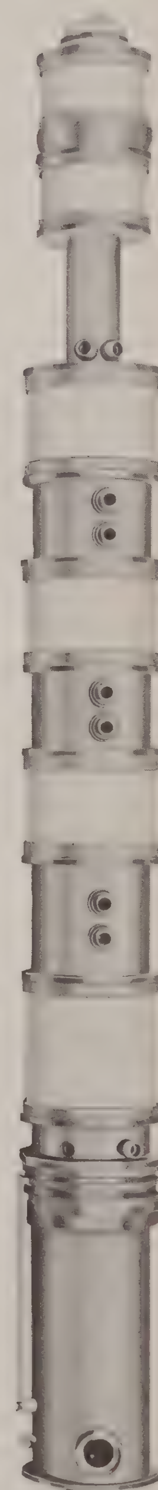
EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM170,000LA

POWER AMPLIFIER

L-BAND KLYSTRON



The Eimac 4KM170,000LA is a four-cavity, magnetically-focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 325 and 500 megacycles and under narrow-band conditions will deliver a minimum CW output power of 75 kilowatts with a power gain of at least 45 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 4KM170,000LA are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-142 for use with the 4KM170,000LA, covers the frequency range of 325 to 500 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an Eimac Air-System Socket. The H-142 Klystron Amplifier Circuit Assembly conforms generally to Military Environmental Specification MIL-E-4970A (USAF) and the general Military Specification, MIL-E-4158B (USAF), for electronic ground equipment.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage (±5%) - -	11	volts
	Current - - -	23	amperes
	Maximum Starting Current -	50	amperes
Cathode:	EMA, Unipotential		
	Heating Time - -	5	minutes
Getter (Operating):			
	Voltage (Nominal) - -	9.1	volts
	Current - - -	36	amperes
Power Gain: (Narrow-Band)	- -	45	decibels
Minimum Output Power (CW)	-	75,000	watts
Frequency Range (H-142 Circuit Assembly)		325 to 500	megacycles

MECHANICAL

Operating Position			Vertical, cathode end up
R-F Input Coupling			Type "N" coaxial fitting
R-F Output Coupling			50-ohm, 6 1/8" line
Weight (Tube Only)			196 pounds
Shipping Weight (Approximate)			410 pounds

Cooling: Water or 60% Ethylene-Glycol Solution and Forced Air

	Flow Rate	Pressure Drop
Cathode	*50 cfm air	1 inch H_2O
Output Cavity	*50 cfm air	6 inches H_2O
Five Drift-Tube sections in series	10 gpm	See curves
Collector	50 gpm	See curves

MAXIMUM RATINGS

D-C BEAM VOLTAGE	35	KILOVOLTS
D-C BEAM CURRENT	5	AMPERES
D-C FOCUS ELECTRODE VOLTAGE	-1000	VOLTS
D-C BODY CURRENT	250	MILLIAMPERES
COLLECTOR DISSIPATION	170	KILOWATTS
A-C GETTER CURRENT	50	AMPERES
SEAL TEMPERATURES	175	DEGREES C

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

		Min.	Max.	
Prefocus Coil:	Voltage	0	25	volts
	Current	0	2	amperes
Each of Three Body Coils				
	Voltage	0	25	volts
	Current	0	15	amperes
Collector Coil:	Voltage	0	25	volts
	Current	0	6	amperes

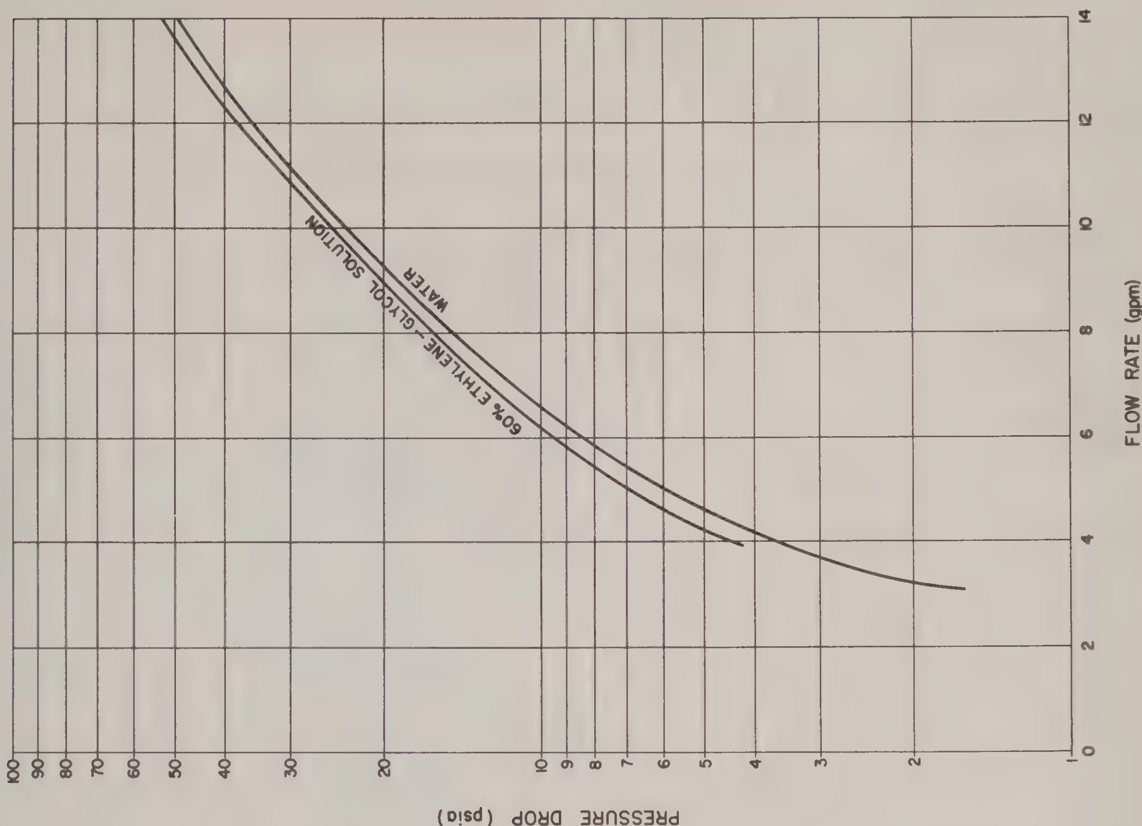
TYPICAL OPERATION, CW AMPLIFIER

Frequency	325	400	500	megacycles
Output Power	75.5	80.5	77	kilowatts
Driving Power	0.8	0.5	0.5	watt
Power Gain	49.7	52.1	51.9	decibels
Power Input	185	185	185	kilowatts
D-C Beam Voltage	35	35	35	kilovolts
D-C Beam Current	5.28	5.28	5.28	amperes
Beam Efficiency	40.8	43.5	41.7	percent
D-C Body Current	220	190	210	milliamperes
D-C Collector Current	5.06	5.09	5.17	amperes
Focus Electrode Voltage	-400	-400	-400	volts

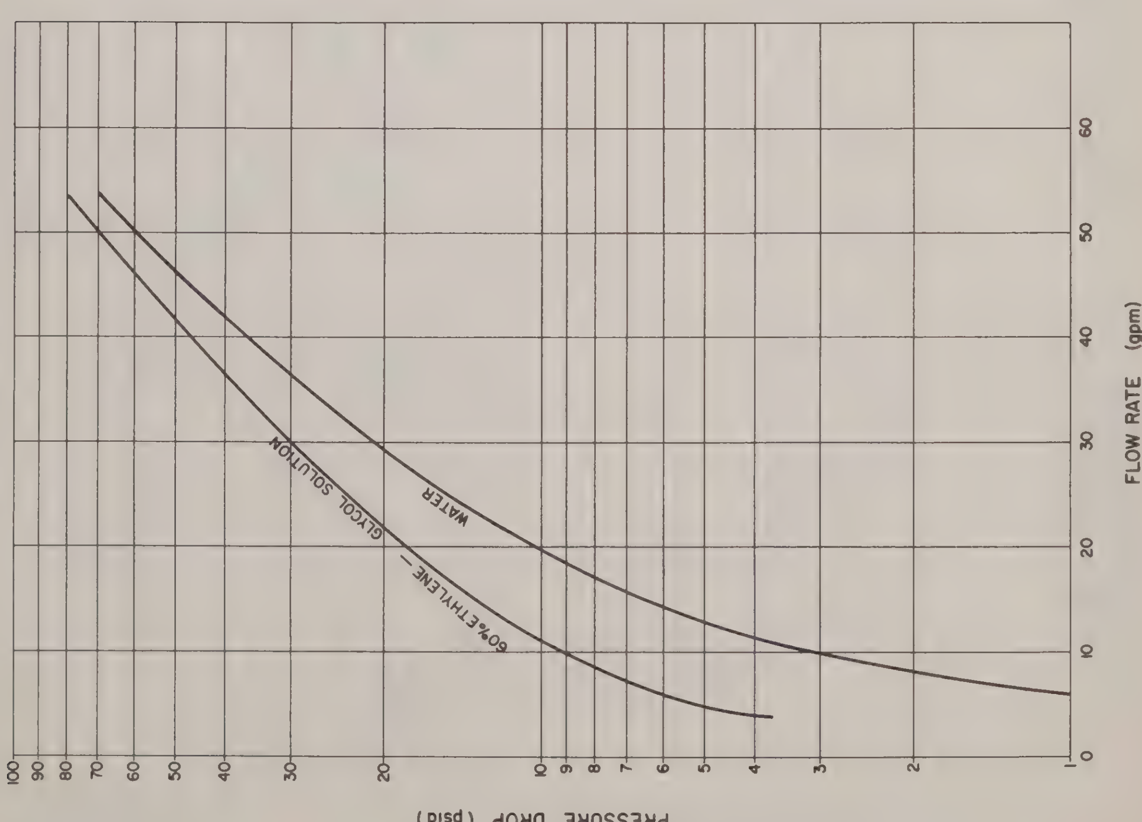
*At Sea Level with 20^{o} C inlet air temperature.

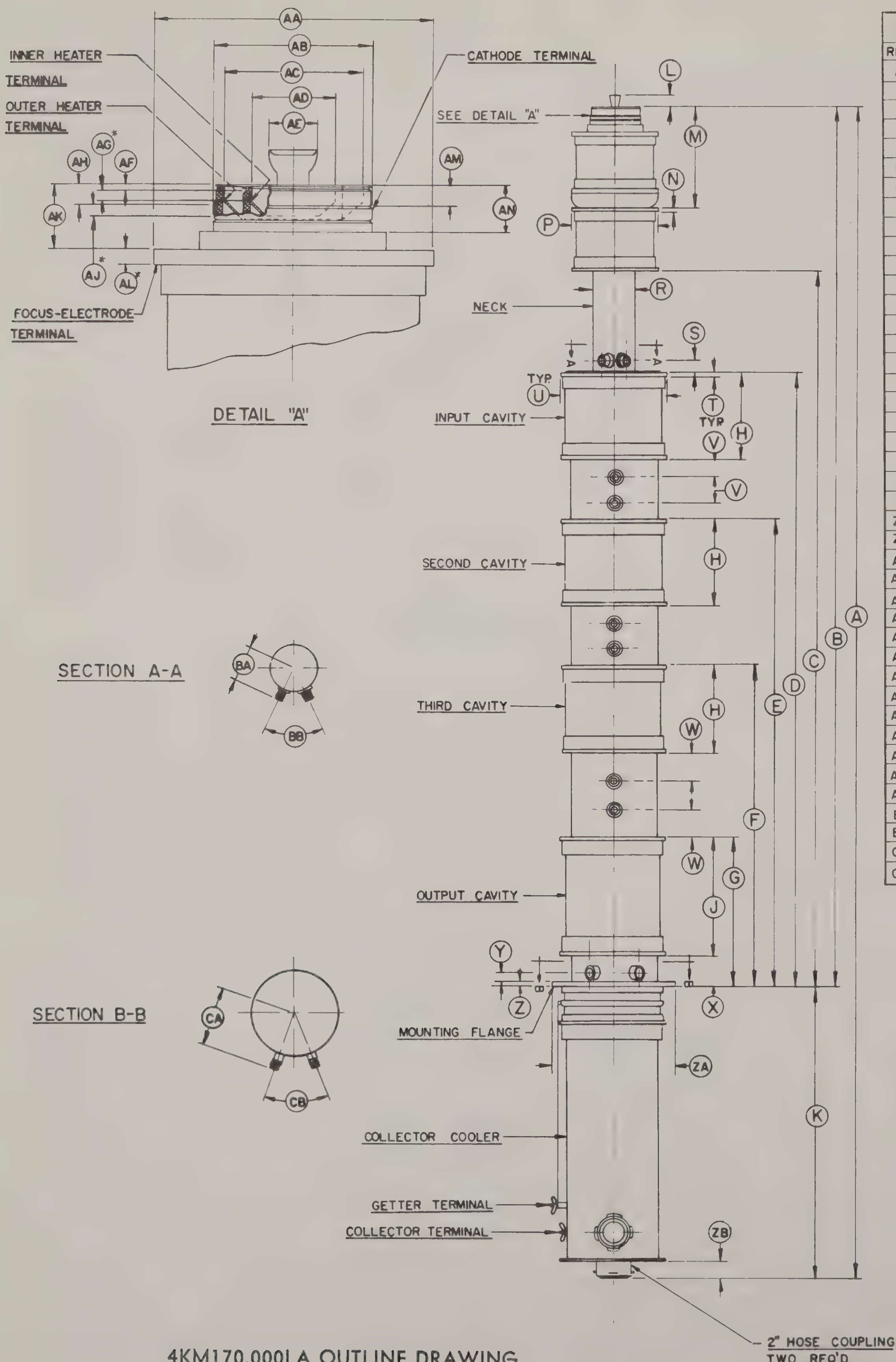
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EIMAC 4KM170,000LA
PRESSURE DROP VS COOLANT FLOW RATE
FIVE DRIFT TUBE JACKETS IN SERIES



EIMAC 4KM170,000LA
PRESSURE DROP VS COOLANT FLOW RATE
ACROSS COLLECTOR





DIMENSIONAL DATA	
REF.	NOM.
A	86 1/2
B	67 1/4
C	54 7/8
D	44
E	35 3/4
F	24 1/2
G	11 1/4
H	6 3/4
J	8 3/4
K	19 5/8
L	1 3/4
M	7 9/16
N	23/64
P	6 5/8
R	3 1/8
S	7/8
T	3/8
U	8 1/8
V	1 9/32
W	2 1/4
X	2 1/4
Y	11/16
Z	5/8
ZA	9 1/2
ZB	1 1/8
AA	6 5/8
AB	3 3/4
AC	3 3/16
AD	1 15/16
AE	1 1/8
AF	5/16
AG	1/4
AH	3/4
AJ	1/8
AK	1 3/4
AL	3/8
AM	21/32
AN	1 5/16
BA	2 3/8
BB	50°
CA	4 1/2
CB	50°

4KM170,000LA OUTLINE DRAWING

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KMP10,000LF

PULSE AMPLIFIER

L-BAND KLYSTRON

The Eimac 4KMP10,000LF is a four-cavity, magnetically focused, pulse-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 570 and 630 megacycles and will deliver a minimum pulse output power of 200 kilowatts at two percent duty, or 400 kilowatts at one percent duty, with an average power of four kilowatts. Nominal power gain is 57 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. A modulating anode voltage of approximately one half the beam voltage is sufficient to realize full rated pulse output power.

The resonant cavities for the 4KMP10,000LF are completed through tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range, and allows external cavity loading for broad-band operation. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-127, for use with the 4KMP10,000LF, covers the frequency range of 570 to 630 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an Eimac SK-1200 socket.

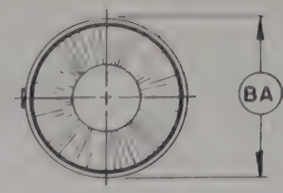
CHARACTERISTICS

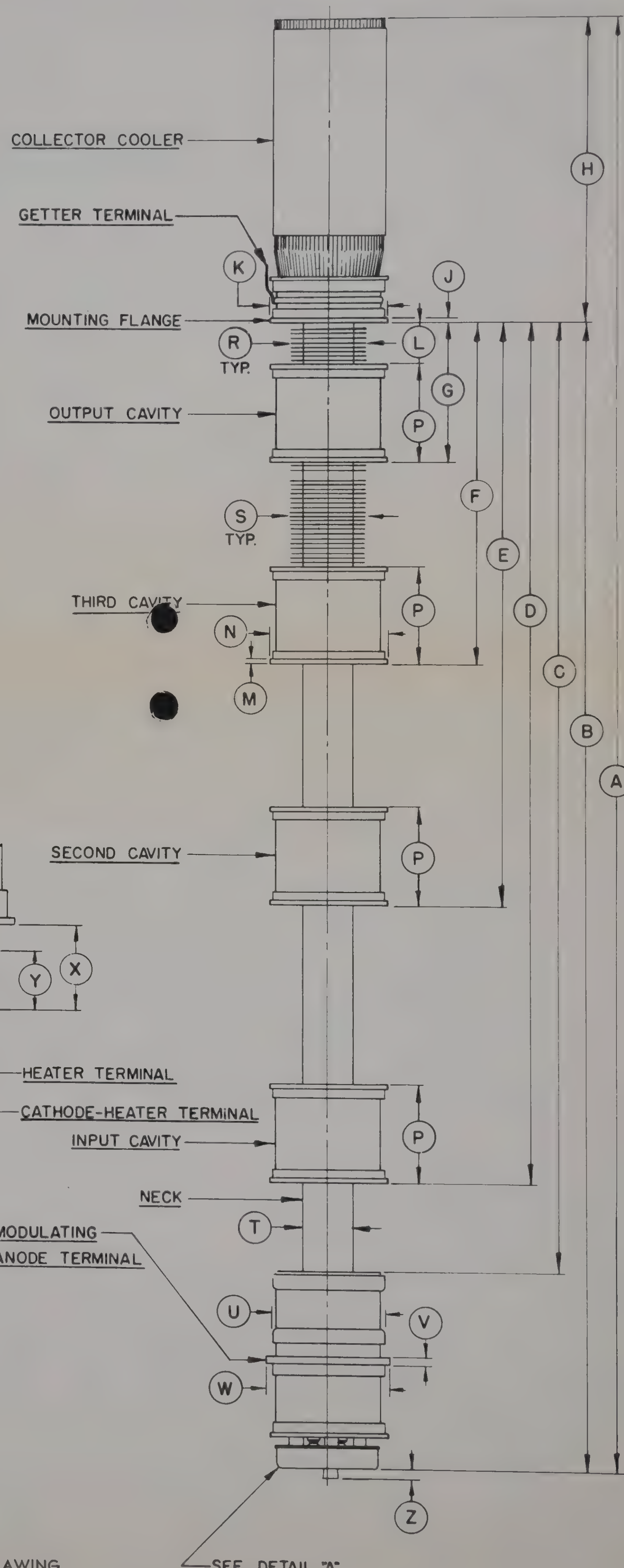
ELECTRICAL

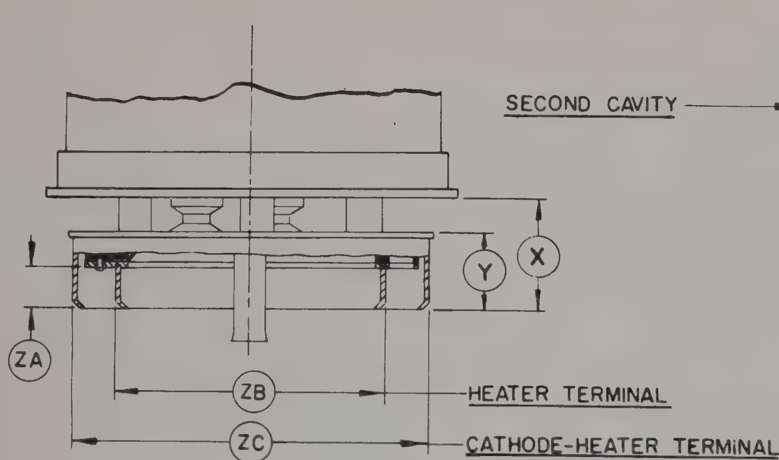
Heater:	Voltage (±5%)	11	volts
	Current (Normal)	22	amperes
	Maximum Starting Current	50	amperes
Cathode:	Unipotential, Oxide Coated		
	Heating Time	10	minutes
Getter (Operating):	Voltage (Nominal)	5.1	volts
	Current	36	amperes
	Maximum Starting Current	50	amperes
Power Gain:	(Narrow Band)	57	decibels
Output Power:			
	2% Duty	200	kilowatts
	1% Duty	400	kilowatts
	Average	4	kilowatts
Frequency Range		570 to 630	megacycles
Capacitance between Modulating Anode and all other Tube Elements:			
	Maximum	60	micromicrofarads
	Typical	37	micromicrofarads

Printed in U.S.A. 585

DIMENSIONAL DATA	
REF.	NOM.
A	84
B	66 1/4
C	54 7/8
D	50 5/32
E	34 3/16
F	20 1/4
G	10 1/2
H	17 13/16
J	1/4
K	6 5/8
L	2 1/4
M	1/4
N	6 5/8
P	6 1/64
R	4 7/16
S	4
T	2 1/2
U	6 5/8
V	3/8
W	6 7/8
X	1 3/4
Y	1 9/32
Z	1
ZA	1/2
ZB	4 3/8
ZC	5 3/4
BA	6 11/32







DETAIL "A"

4KMP10,000LF OUTLINE DRAWING

MECHANICAL

Operating Position	Axis Vertical Cathode down (in oil)
R-F Input Coupling	Type N Coaxial Fitting
R-F Output Coupling	WR1500 Waveguide
Weight (Tube only)	140 pounds

Cooling: Forced Air and Oil

Cathode (With SK-1200 socket) - oil

	Flow Rate	Pressure Drop
Body	*100 cfm air	1 inch H_2O
Output Cavity	*50 cfm air	1 inch H_2O
Collector	*400 cfm air	2.5 inches H_2O

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS
(Eimac H-127 Klystron Amplifier Circuit Assembly)

		Min.	Max.	
Prefocus Coil:	Voltage (dc)	0	40	volts
	Current (dc)	0	2.5	amperes
Each of Five Body Coils:				
	Voltage (dc)	0	40	volts
	Current (dc)	0	12.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	70	KILOVOLTS
PEAK D-C BEAM CURRENT	22.5	AMPERES
PEAK MODULATING ANODE VOLTAGE	44	KILOVOLTS
AVERAGE D-C BODY CURRENT	15	MILLIAMPERES
COLLECTOR DISSIPATION	10	KILOWATTS
PULSE LENGTH	60	MICROSECONDS
SEAL TEMPERATURES	175	DEGREES C
A-C GETTER CURRENT	50	AMPERES

TYPICAL OPERATION, NARROW BAND PULSE AMPLIFIER

Frequency	600	megacycles
Peak Output Power	466	kilowatts
Average Output Power	4.66	kilowatts
Peak Driving Power	0.8	watts
Power Gain	57.4	decibels
D-C Beam Voltage	65	kilovolts
Average D-C Beam Current	165	milliamperes
Peak D-C Beam Current	16.5	amperes
Peak Modulating Anode Voltage	32	kilovolts
D-C Body Current (Average)	9.5	milliamperes
D-C Collector Current (Average)	156	milliamperes
Beam Input Efficiency (Average)	43.4	percent

MAGNETIC-COIL CURRENTS (H-127 Circuit Assembly)

Prefocus Coil	1.9	amperes
First Body Coil	6.3	amperes
Second Body Coil	7.5	amperes
Third Body Coil	7.5	amperes
Fourth Body Coil	8.5	amperes
Fifth Body Coil	8.5	amperes

*At Sea Level with 20° C inlet air temperature.

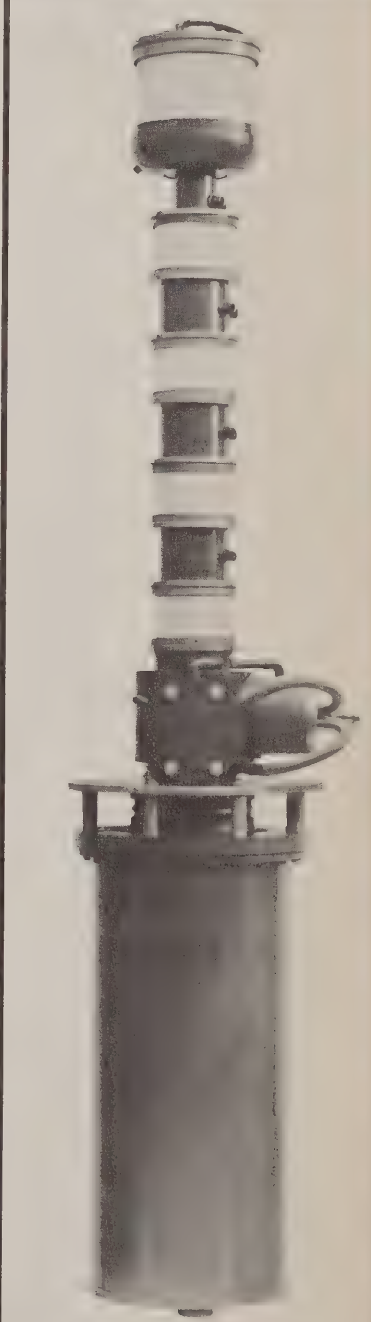
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

5K210,000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 5K210,000LQ is a high-gain, power-amplifier klystron designed for wide-band, tropospheric-scatter, communications service at frequencies from 755 to 985 megacycles. This klystron will deliver a CW output power of 75 kilowatts, with a minimum power gain of 42 decibels, and half-power band-width of 10 megacycles.

Five resonant cavities are used in the 5K210,000LQ. Four are external and one, the output cavity, is integral. Output coupling is achieved by means of a fixed loop and a quarter-wave, variable-impedance, coaxial coupling section which terminates in a waveguide transition.

The 5K210,000LQ has a beam microperveance of 2 which makes it possible to achieve adequate bandwidth for tropo-scatter applications without external loading of the intermediate cavities.

Eimac Klystron Amplifier Circuit Assembly H-132 has been designed for use with the 5K210,000LQ to cover the specified frequency range. This assembly includes a supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for the input and output cavities, and a coaxial-to-waveguide transition.

CHARACTERISTICS

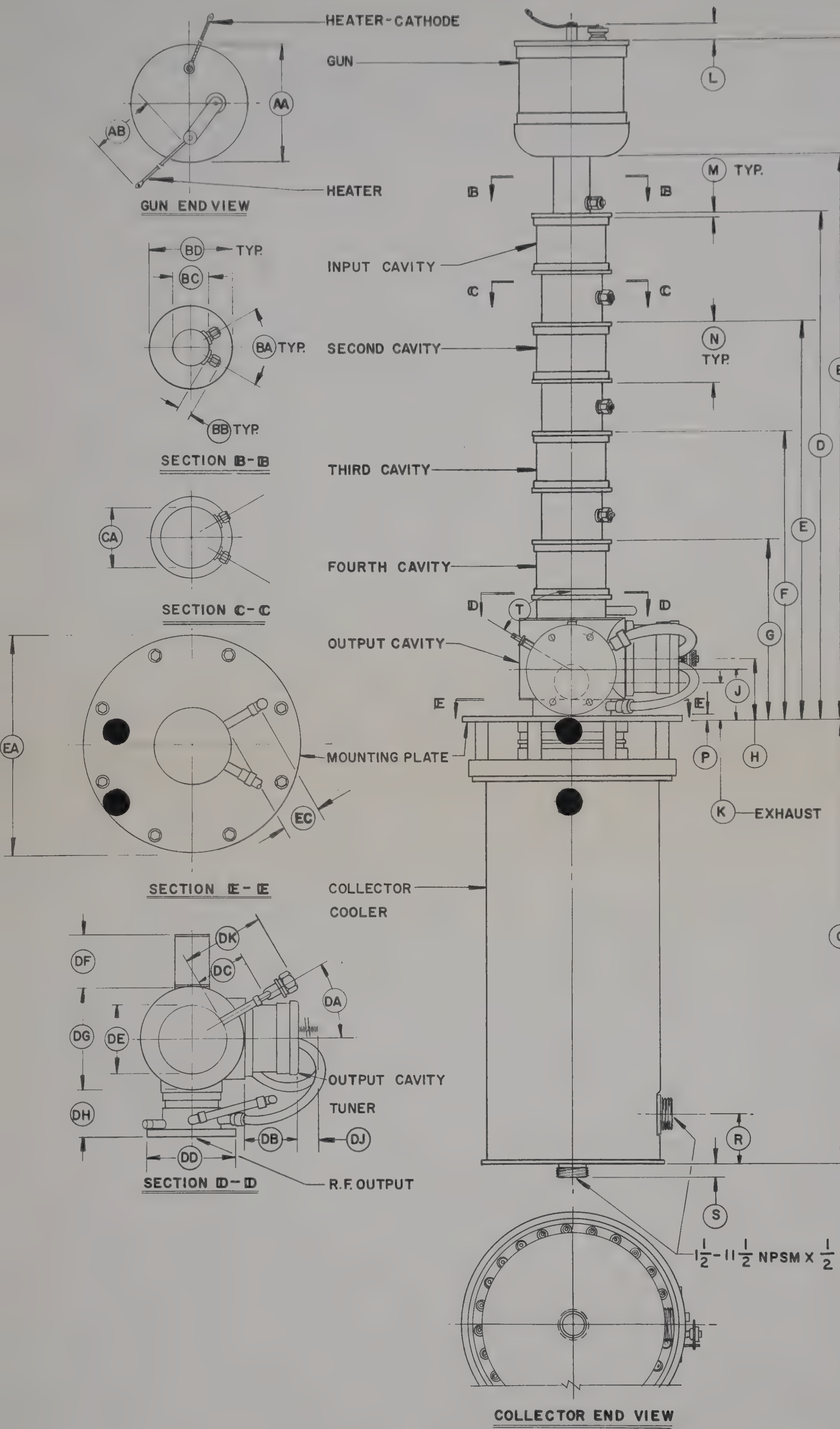
ELECTRICAL

Heater:	Voltage	15	volts
	Current	18	amperes
	Maximum Starting Current	36	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	Voltage	5.2	volts
	Current	36	amperes
Power Gain (Wide Band)		42	decibels
Output Power		75	kilowatts
Frequency Range (H-132 Circuit Assembly)		755 to 985	megacycles

MECHANICAL

Operating Position		Axis vertical, cathode up	
R-F Coupling:			
	Input	Type "N" coaxial fitting	
	Output	WR-975 Waveguide	
Weight (5K210,000LQ Klystron)		380	pounds
Weight (H-132 Circuit Assembly)		1530	pounds
Cooling:	Water and Forced Air		

	Flow Rate	Pressure Drop
Second, Third and Penultimate Cavities (each)	25 cfm	1 inch H_2O
Body and Output Section	6 gpm	25 psi
Collector	50 gpm	25 psi



DIMENSIONAL DATA			
ITEM	NOM.	MIN.	MAX.
A	64.787		
B		32.244	32.786
C		25.361	25.613
D		29.066	29.544
E		22.854	23.252
F		16.642	16.960
G		10.430	10.668
H		3.576	3.728
J		2.951	3.103
K		2.206	2.348
L		29/32	1 3/32
M		.245	.255
N		3.481	3.523
P		23/64	25/64
R		2 53/64	2 59/64
S		21/32	23/32
T			
AA		6.620 DIA.	6.630 DIA.
AB		8	9
BA	60°		
BB	39/64		
BC	2.125 DIA.		
BD		4.620 DIA.	4.630 DIA.
CA	3.500 DIA.		
DA	30°		
DB		3	3 5/32
DC	2 15/32		
DD		5 11/64 DIA.	5 13/64 DIA.
DE	4.000 DIA.		
DF	4	[illegible]	
DG		6.00[illegible] DIA.	6.010 DIA.
DH		2 35/64	2 43/64
DJ		1.152	1.222
DK		[illegible]	
EA		12.748 DIA.	12.752 DIA.
EB			
EC			
ED			

5K210,000LQ KLYSTRON

MECHANICAL cont.

Maximum Dimensions of Klystron:		
Length	66.6	inches
Diameter	14	inches
Maximum Dimensions (Klystron and Circuit Assembly):		
Height	75	inches
Width	32	inches
Depth	47	inches

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 25	volts
	Current	0 to 2	amperes
Each of Four Body Coils:			
	Voltage	0 to 100	volts
	Current	0 to 12	amperes
Collector Coil:	Voltage	0 to 40	volts
	Current	0 to 5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	30	KILOVOLTS
D-C BEAM CURRENT	10	AMPERES
D-C BODY CURRENT	300	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
COLLECTOR DISSIPATION	210	KILOWATTS

TYPICAL OPERATION, WIDE-BAND, CW AMPLIFIER

RF Frequency	860	megacycles
Output Power	81	kilowatts
Driving Power	3	watts
Power Gain	44.3	decibels
D-C Beam Voltage	25	kilovolts
D-C Beam Current	7.52	amperes
Efficiency	43	percent
D-C Body Current	120	milliamperes
Half-Power Bandwidth	10.9	megacycles
Magnetic-Coil Currents:		
Prefocus coil	0.97	ampere
Body Coil #1	8.7	amperes
Body Coil #2	8.2	amperes
Body Coil #3	8.5	amperes
Body Coil #4	7.6	amperes
Collector Coil	3.6	amperes

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X626AC

PULSE-AMPLIFIER L-BAND KLYSTRON

The Eimac X626AC is a three-cavity, pulse-amplifier klystron designed for high-average-power pulse service at frequencies from 400 to 450 megacycles. This klystron will deliver a peak output power of 1.25 megawatts, at 75 kilowatts average power, with a narrow-band power gain of 30 decibels.

All tuning is accomplished outside the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits external cavity loading for wide-band applications. For spares or replacements, only the basic klystron, without cavities, need be purchased.

This klystron employs the Eimac Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. The electron-gun geometry is such that the required beam current is obtained with a peak modulating-anode voltage of only 52 kilovolts, at the rated beam voltage of 100 kilovolts.

Waveguide output coupling for the X626AC is achieved by means of an adjustable iris in the output cavity.

Eimac Klystron Amplifier Circuit Assembly H-123B has been designed for use with the X626AC to cover the specified frequency range. This assembly includes a supporting structure, magnetic focusing coils, tuning cavities, input load coupler, output waveguide transition, and a klystron socket.

CHARACTERISTICS

ELECTRICAL

Cathode:	EMA, Unipotential		
	Minimum Heating Time - - -	10	minutes
Heater:	Voltage (±5%) - - - - -	7.5	volts
	Current - - - - - -	90 to 100	amperes
	Maximum Starting Current - -	200	amperes
Getter:	Voltage - - - - - - -	15.6	volts
	Current - - - - - - -	36	amperes
Modulating Anode Capacitance (to all other electodes):			
	Dry - - - - - - -	45	$\mu\mu f$
	In Typical Circuit (oil immersed)	125 to 150	$\mu\mu f$
Power Gain (Narrow Band)		30	decibels
Peak Output Power - - - - - -		1.25	megawatts
Average Output Power - - - - -		75	kilowatts
Frequency Range (H-123B Circuit Assembly)		400 to 450	megacycles

MECHANICAL

Operating Position - - - - - - - - -	Vertical, Cathode Down
R-F Input Coupling - - - - - - - - -	1 5/8 inch, 50-ohm line
R-F Output Coupling - - - - - - - - -	WR-2100 Waveguide
Weight (X626AC only) - - - - - - - -	590 pounds

MECHANICAL cont.

Weight (H-123B Circuit Assembly)	1780	pounds
Maximum Dimensions (X626AC)		
Length	118	inches
Diameter	18	inches
Maximum Dimensions (X626AC and H-123B Circuit Assembly)		
Height	120	inches
Width	38	inches
Depth	38	inches

Cooling: Oil, Water and Forced Air
Electron Gun: Immersed in Oil

	Flow Rate	Pressure Drop
Penultimate and Output Cavities	250 cfm	3 inches H_2O
Four Drift-Tube Sections in Series	5 gpm	5.5 psi
Collector	50 gpm	26 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 60	volts
	Current	0 to 2	amperes
First Body Coil:	Voltage	0 to 100	volts
	Current	0 to 2	amperes
Each of Three Body Coils and Collector Coil:	Voltage	0 to 150	volts
	Current	0 to 6	amperes

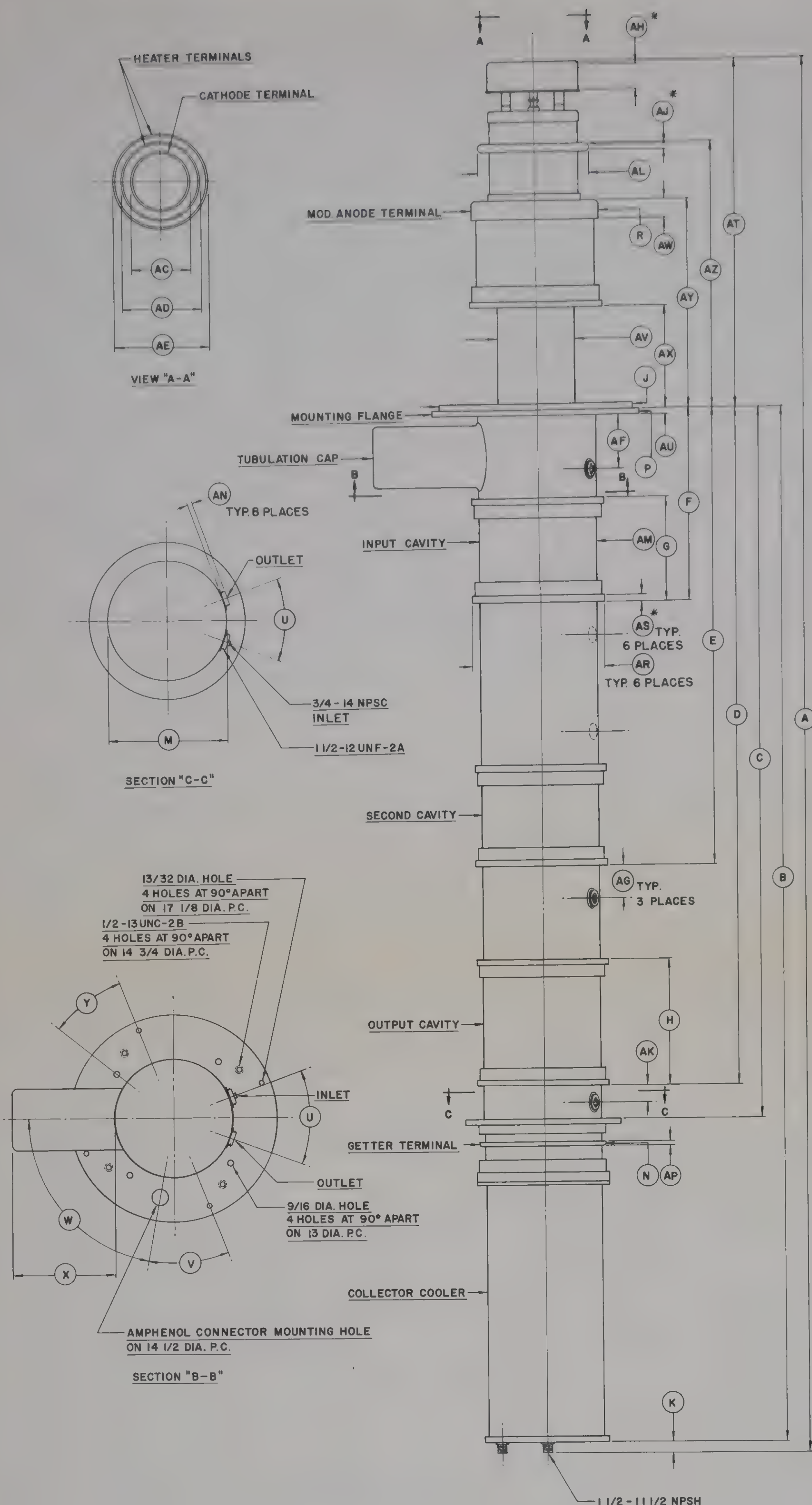
MAXIMUM RATINGS

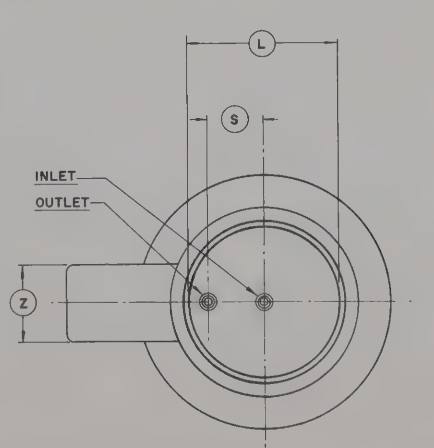
D-C BEAM VOLTAGE	110	KILOVOLTS
PEAK BEAM CURRENT	36.5	AMPERES
PEAK MODULATING-ANODE VOLTAGE	66	KILOVOLTS
AVERAGE D-C BODY CURRENT	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
COLLECTOR DISSIPATION	240	KILOWATTS
SEAL TEMPERATURES	175	DEGREES C
D-C FOCUS-ELECTRODE VOLTAGE	-500	VOLTS

TYPICAL OPERATION, NARROW-BAND, PULSE AMPLIFIER

Frequency	425	megacycles
D-C Beam Voltage	100	kilovolts
Peak Modulating-Anode Voltage	52	kilovolts
Peak Beam Current	32.5	amperes
Average D-C Body Current	130	milliamperes
Peak Output Power	1.25	megawatts
Average Output Power	75	kilowatts
Peak Drive Power	1.25	kilowatts
Power Gain	30	decibels
Peak Beam Power Efficiency	38.4	percent
Focus-Electrode Voltage	-50	volts
Pulse Width	2000	microseconds
Pulse Repetition Rate	30	pulses/second
Duty	0.06	
Electron-Gun Microperveance	2.6	
Beam Microperveance	0.98	
Magnetic-Coil Currents		
Prefocus Coil	1.4	amperes
First Body Coil	1.0	ampere
Second, Third & Fourth Body Coil and Collector Coil (each)	4.0	amperes

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.

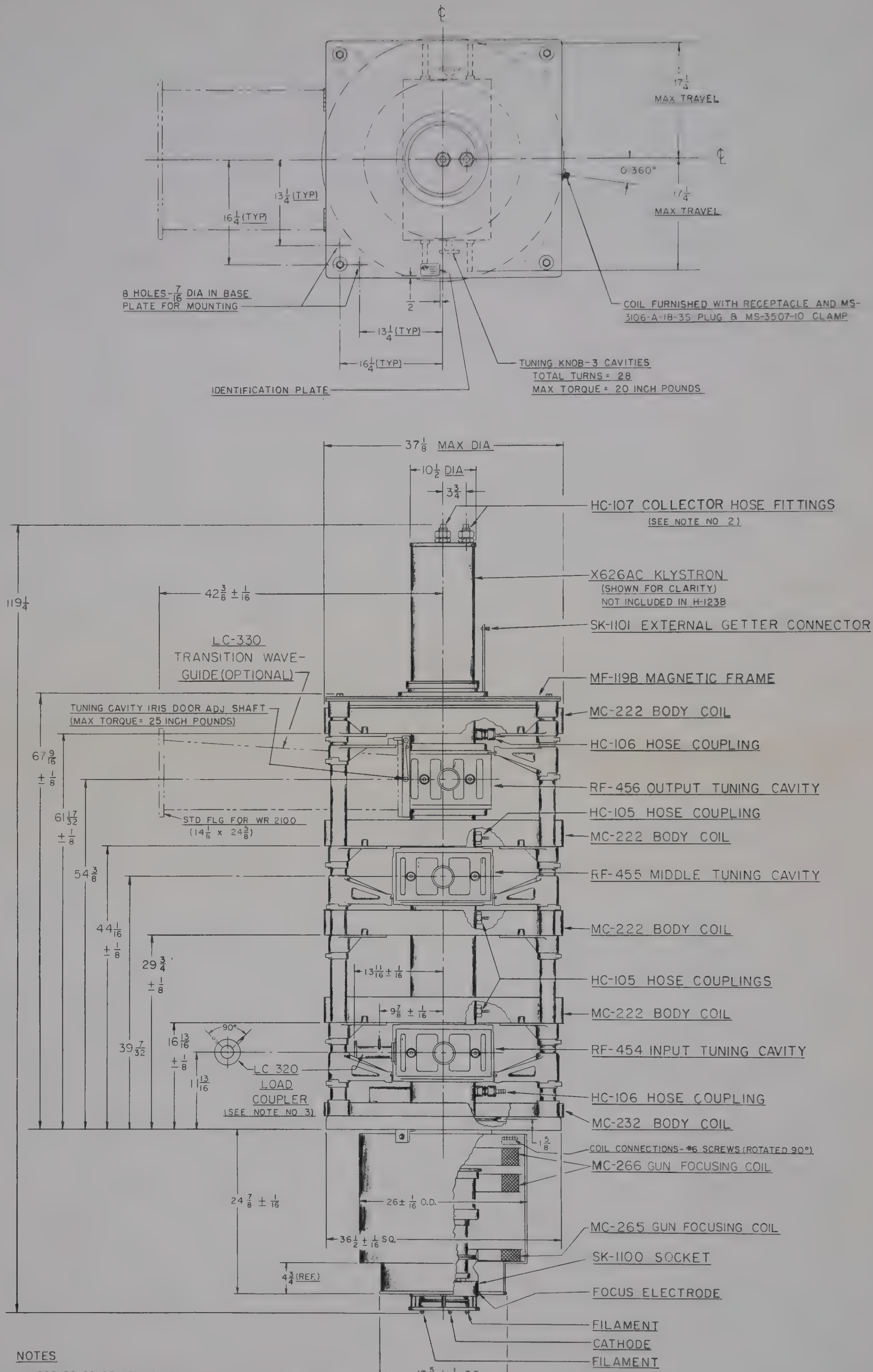




DIMENSIONAL DATA			
REF	NOM	MIN	MAX
A	117.5		
B	89.3		
C		60.7[illegible]	61 20
D	58.0		
E	42 0		
F	14.6		
G		8 790	8.842
H		10.429	10 481
J		16 375	16.500
K		600	
L	10.5		
M	10.0		
N	10.8		
P		17.875	18.030
R	10.9		
S	3.7		
T			
U	40°		
V	32°		
W	91.5°		
X	6.750		
Y	30°		
Z	4.0		
AA			
AB			
AC		33.970	4 090
AD		6.165	6.285
AE		7.910	8.030
AF	3.75		
AG	2.0		
AH		2.375	
AJ		.5	
AK		1.460	1.560
AL		9.281	9.343
AM	10.045		
AN		.375	
AP		.250	.500
AR		11.490	11.510
AS		.375	
AT		27.290	27.790
AU		.437	
AV	5.0		
AW			
AX	7.5		
AY	15.6		
AZ	20.7		

NOTES:
* 1. MIN. STRAIGHT SURFACE FOR CONTACT.
2. DIMENSIONS ARE INCHES.

X626AC KLYSTRON



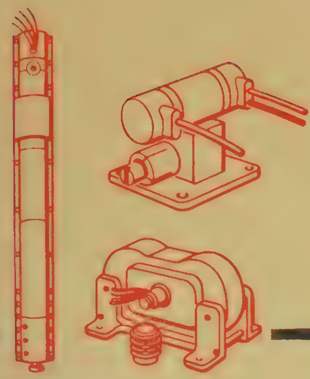
NOTES

1. SOCKET TO BE SPRING MOUNTED IN KLYSTRON TANK TO MIN DIMENSION. MIN SPRING COMPRESSION TO BE $\frac{3}{4}$ INCH.
2. MATING PART (BY CUSTOMER) SNAP-TITE COUPLER HALF NO H24-2009-38
3. STD $1\frac{5}{8}$ UHF COAX FLANGE ON LOAD COUPLER

PARTS NOT SHOWN

HT-105 EXTENSION WRENCH
HT-106 COUPLING WRENCH
HT-107 WATER FITTING WRENCH

H-123B KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY



reflex klystrons · twt · vtm

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IMPORTANT EIMAC "EXTRAS"

Application Engineering. The Eimac Application Engineering Department is available at all times for consultation. New tube operating techniques are continually being explored, tested and proved by Eimac engineers, whose combined knowledge and experience are at your service. Additional contributions by this Eimac department are its Application Bulletins, a service which you receive without obligation.

Field Engineering. Serving as an extension of the Application Engineering Department outside the Eimac plant, Eimac Field Engineers cover the United States, operating out of offices in major cities. They will help you personally with experimental work, problems of technique, etc. Engineers from Eitel-McCullough, Inc. are available, too, for field consultation throughout the country. As Eimac tubes are world renowned, the same services extend to various countries overseas through the Eimac Export Department.

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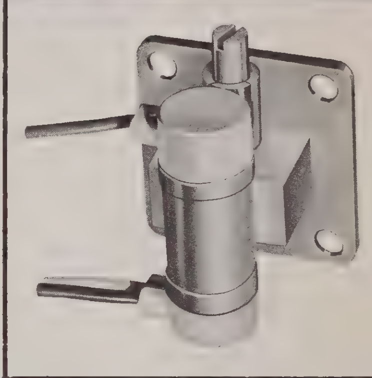
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XD

X-BAND REFLEX KLYSTRON



The Eimac 1K20XD is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 10,000 to 10,7000 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated.	
Warm-up time	30 seconds
Heater: Voltage	6.3 volts
Current	0.8 ampere
Typical Output Power (Load VSWR = 1.15:1)	75 milliwatts
Frequency Range	10,000 to 10,700 megacycles

MECHANICAL

Operating Position	Any
Mounting	UG-39/U waveguide flange
Cooling	Conduction
Electrical Connections	Flexible leads
R-F Output Coupling	RG-52/U waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.30 inches
Width	1.63 inches
Length	2.28 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-Operating Shock (11 ms Duration)	40 g
Maximum Operating Shock* (11 ms Duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE*	350 MAX. VOLTS
D-C CATHODE CURRENT	55 MAX. MA.
RESONATOR DISSIPATION	20 MAX. WATTS
PEAK REPELLER VOLTAGE*	
POSITIVE WITH RESPECT TO CATHODE	0 MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	300	350	volts
Mode	5¾	5¾	
Frequency	10,350	10,350	megacycles
D-C Cathode Current	40	50	milliamperes
D-C Repeller Voltage*	−165	−150	volts
D-C Repeller Current	1	1	microampere
Power Output	50	75	milliwatts
Electronic Tuning (3 db bandwidth)	30	30	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	2.0	2.0	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	50	50	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for D-C isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XD is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

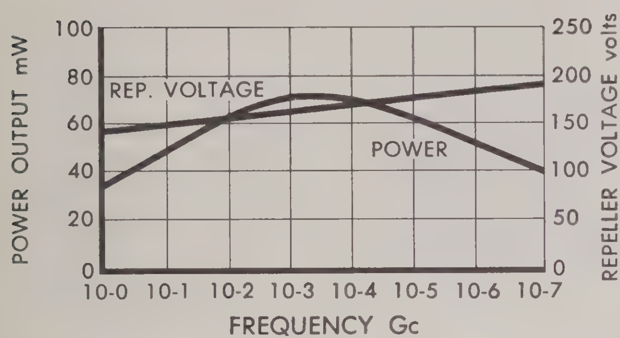
The heater and cathode of the 1K20XD are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

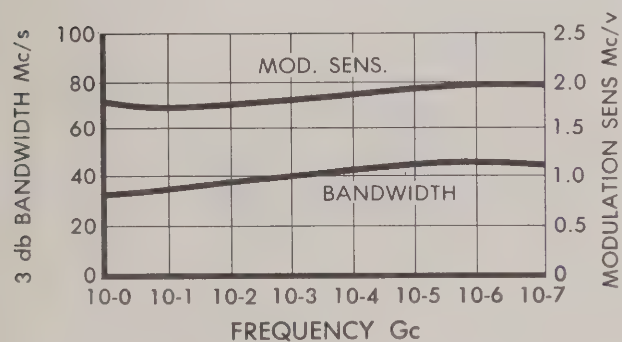
Mechanical Tuning: In the 1K20XD a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical turning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

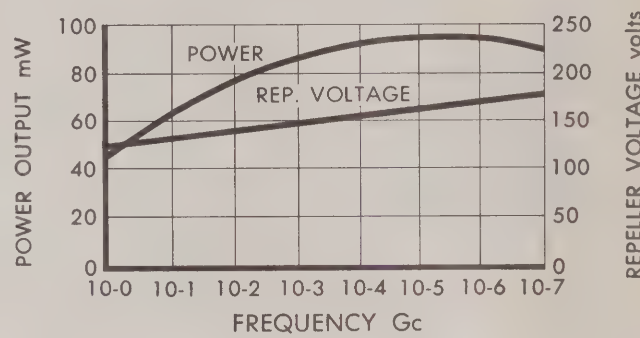
IK20XD TYPICAL OPERATING CHARACTERISTICS

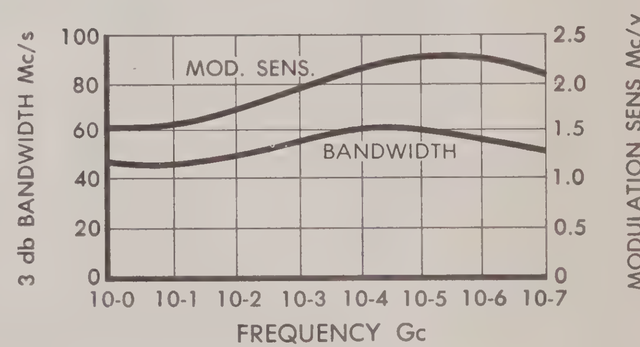
E_{RS} = 350 Vdc
I_K = 50 mAdc
5¾ MODE



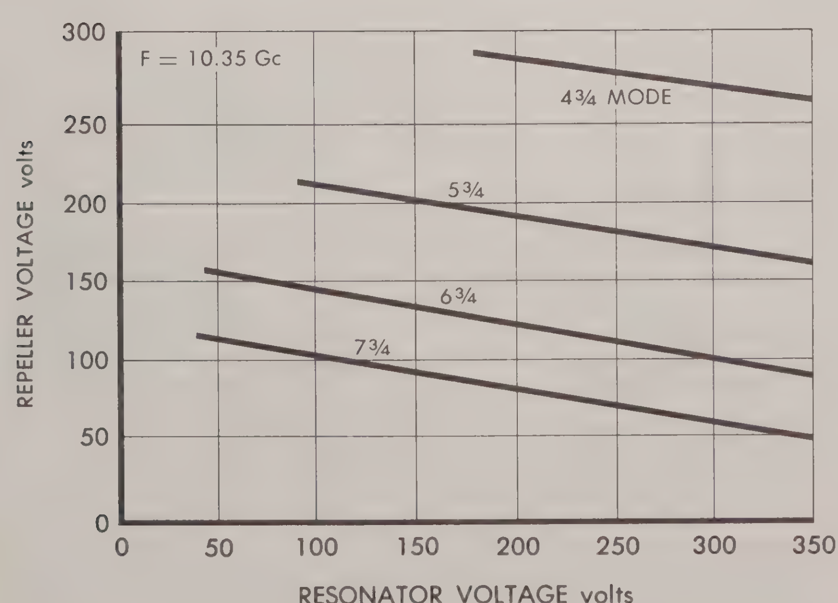


E_{RS} = 300 Vdc
I_K = 40 mAdc
5¾ MODE



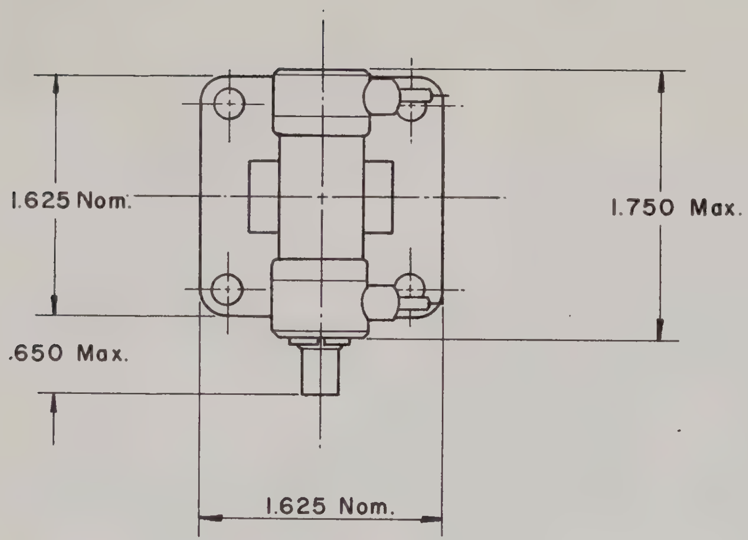


MODE CHARACTERISTICS



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

1K20 XD

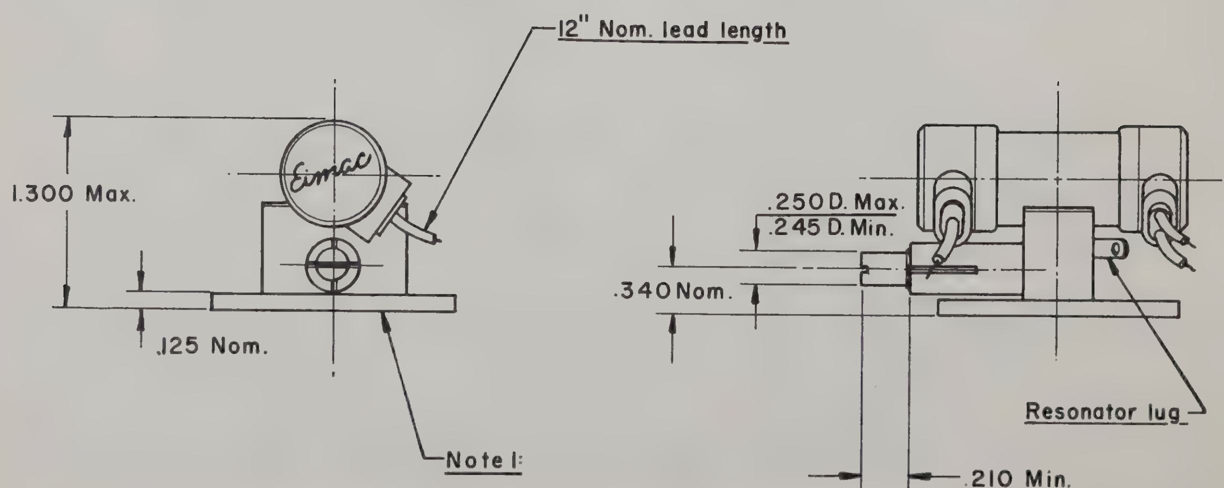


NOTES:

1. Mates with UG-39/U flange for RG-52/U waveguide

CONNECTIONS

1. REPELLER - RED
2. CATHODE - BLACK
3. HEATER - WHITE

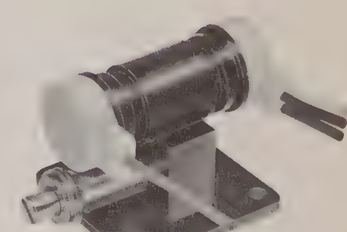


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XD-A

X-BAND REFLEX KLYSTRON



The Eimac 1K20XD-A is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 10,000 to 10,700 megacycles.

The stacked-ceramic construction results in an extremely rugged design and low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR = 1.15:1)		75	milliwatts
Frequency Range		10,000 to 10,700	megacycles

MECHANICAL

Operating Position		Any
Mounting		UG-39/U waveguide flange
Cooling		Conduction
Electrical Connections		Flexible leads
RF Output Coupling		RG-52/U waveguide
Net Weight		4 ounces
Shipping Weight (approximate)		2 pounds
Maximum Overall Dimensions:		
	Height	1.50 inches
	Width	1.63 inches
	Length	2.50 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-Operating Shock* (11 ms Duration)	40 g
Maximum Operating Vibration** (20 to 2,000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.

**Based on a maximum peak-to-peak frequency deviation of 200 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	350 MAX.	VOLTS
DC CATHODE CURRENT	55 MAX.	MA
RESONATOR DISSIPATION	20 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	300	350	volts
Mode	5-3/4	5-3/4	
Frequency	10,350	10,350	megacycles
DC Cathode Current	26	35	milliamperes
DC Repeller Voltage*	-165	-150	volts
DC Repeller Current	1	1	microampere
Power Output	50	75	milliwatts
Electronic Tuning (3db bandwidth)	30	30	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	2.0	2.0	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	200	200	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the body temperature below the maximum rating of 175° Centigrade.

Resonator: The resonator of the 1K20XD-A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

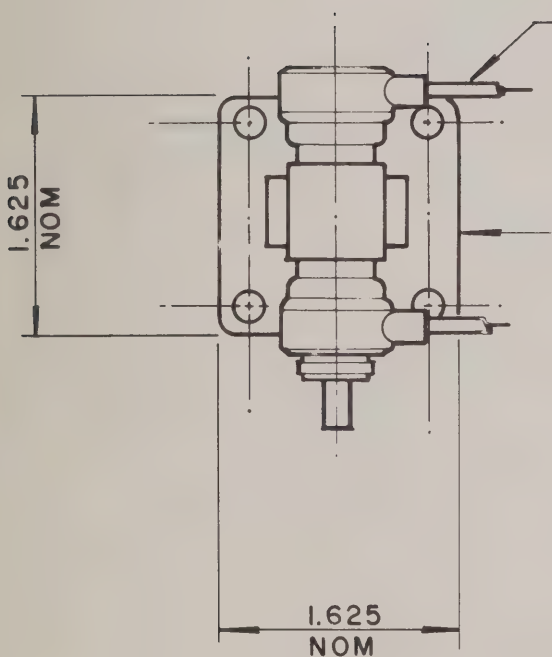
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the 1K20XD-A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the 1K20XD-A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

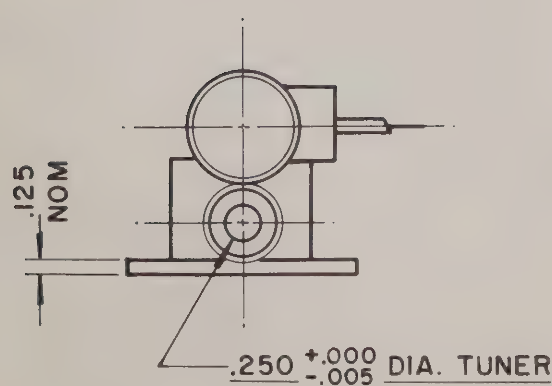
1K20XD-A

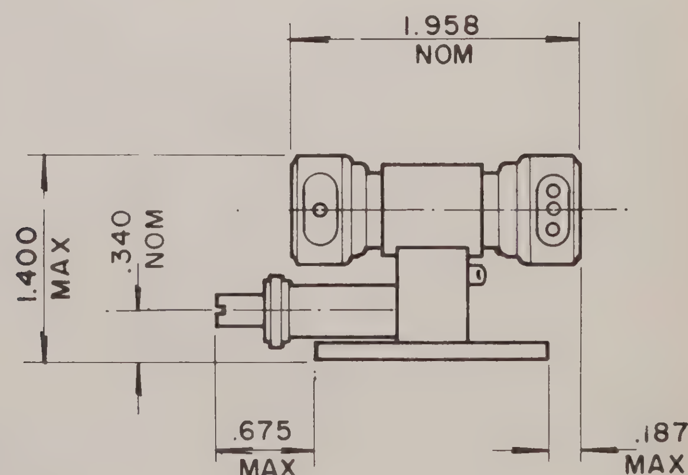


CONNECTIONS

HEATER	WHITE
* CATHODE	BLACK
* HEATER	BLACK
REPELLER	RED

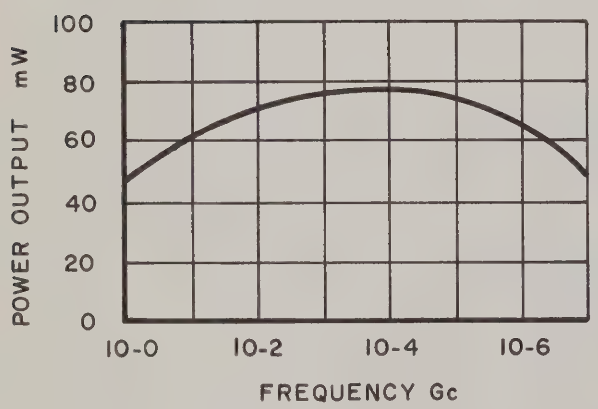
* INTERNALLY CONNECTED

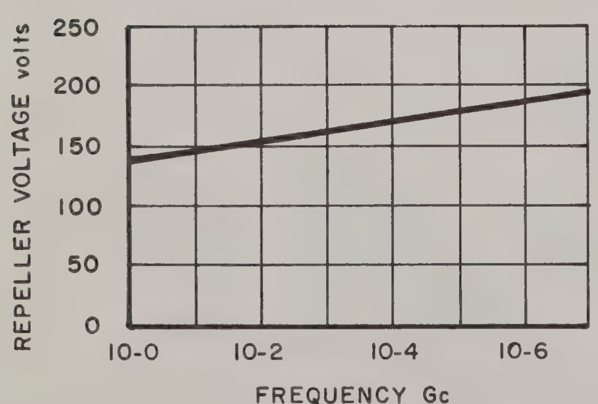




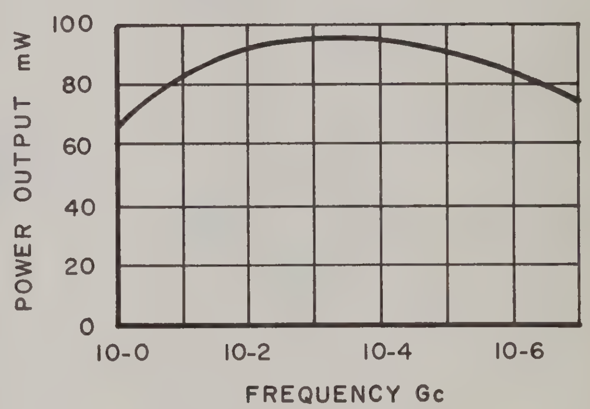
1K20XD-A TYPICAL OPERATING CHARACTERISTICS

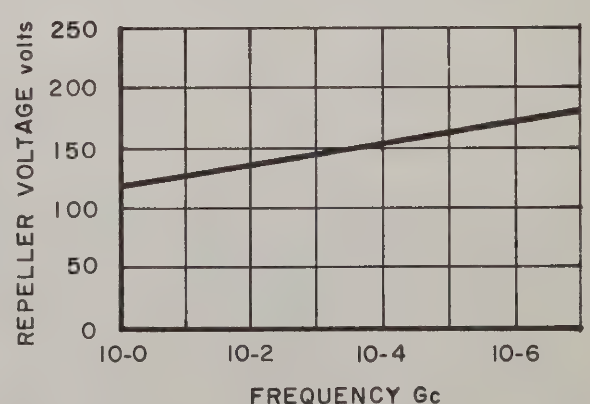
Ers = 300 Vdc
Ik = 26 mAdc
$5\frac{3}{4}$ MODE





Ers = 350 Vdc
Ik = 35 mAdc
$5\frac{3}{4}$ MODE



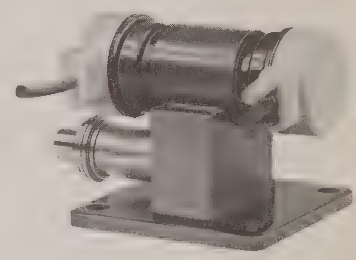


EITEL-McCULLOUGH, INC.

TENTATIVE DATA

1K20XD-S

X-BAND REFLEX KLYSTRON



The Eimac 1K20XD-S is a ceramic and metal, conduction-cooled reflex klystron designed for transmitter or local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 120 milliwatts over the frequency range of 10,500 to 11,000 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	1.0	ampere
Minimum Output Power (Load VSWR 1.15:1)		100	milliwatts
Frequency Range		10,500 to 11,000	megacycles

MECHANICAL

Operating Position		any
Mounting		UG-39/U waveguide flange
Cooling		conduction
Electrical Connections		flexible leads
RF Output Coupling		RG-52/U waveguide
Net Weight	4	ounces
Shipping Weight (Approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.50	inches
Width	1.63	inches
Length	2.50	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C	
Maximum Altitude	No limit	
Maximum Non-Operating Shock* (11 ms Duration)	40	g
Maximum Operating Vibration** (20 to 2000 cps)	10	g
Maximum Operating Shock* (11 ms Duration)	40	g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 200 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	450 MAX.	VOLTS
DC CATHODE CURRENT	45 MAX.	MA
RESONATOR DISSIPATION	25 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15:1)

DC Resonator Voltage*	400	volts
Mode		5-3/4
Frequency	10,750	megacycles
DC Cathode Current	40	milliamperes
DC Repeller Voltage*	-175	volts
DC Repeller Current	1	microampere
Power Output	120	milliwatts
Electronic Tuning (3 db bandwidth)	30	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	1.7	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	200	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-ceramic seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XD-S is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

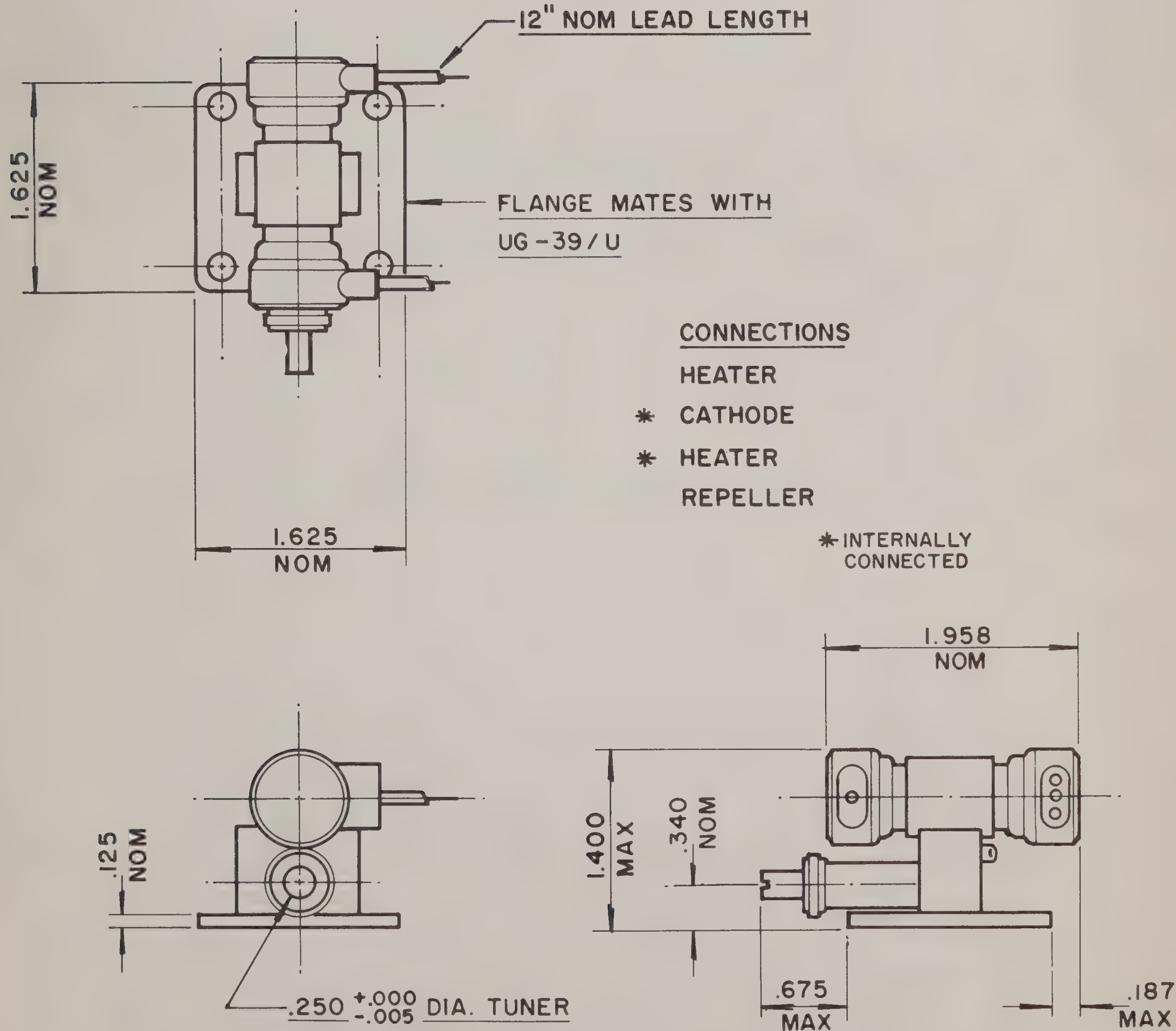
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the 1K20XD-S are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the 1K20XD-S a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

1K20XD-S

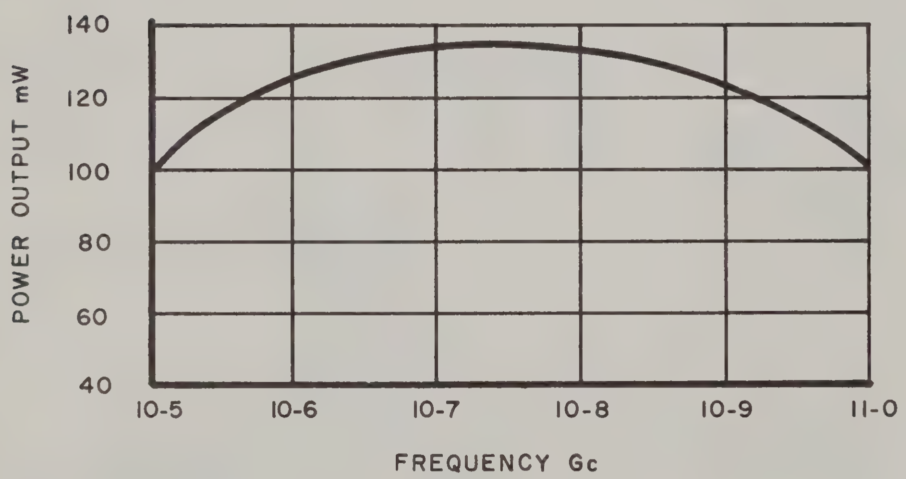

12" NOM LEAD LENGTH
1.625 NOM
FLANGE MATES WITH UG-39/U
CONNECTIONS
HEATER
* CATHODE
* HEATER
REPELLER
* INTERNALLY CONNECTED
1.625 NOM
1.958 NOM
.125 NOM
1.400 MAX
.340 NOM
.250 +.000 -.005 DIA. TUNER
.675 MAX
.187 MAX

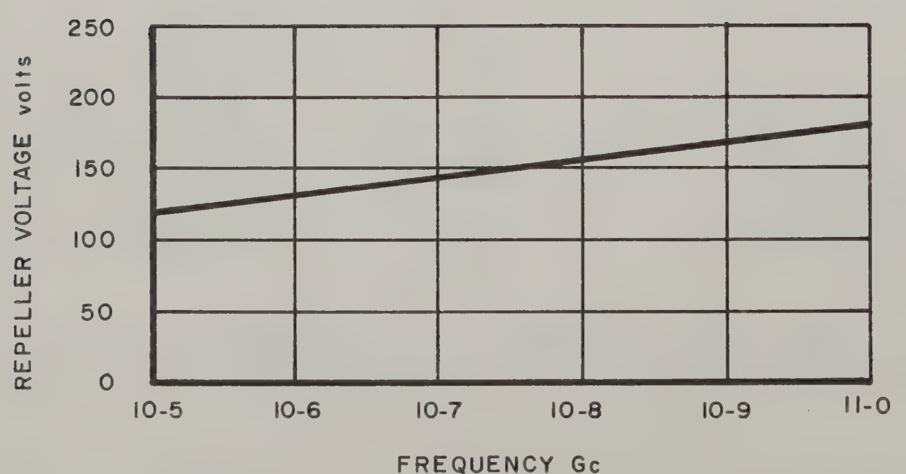
1K20XD-S TYPICAL OPERATING CHARACTERISTICS

Ers = 400 Vdc

Ik = 40 mAdc

$5\frac{3}{4}$ MODE





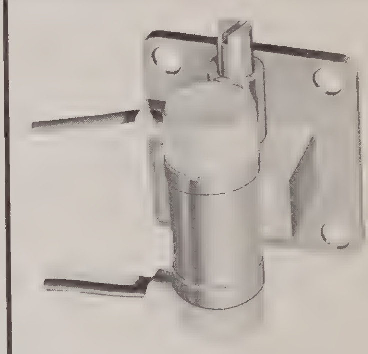
EITEL-McCULLOUGH, INC.

TENTATIVE DATA

1K20XK

X-BAND

REFLEX KLYSTRON



The Eimac 1K20XK is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 9200 to 10,000 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated.	
Warm-up time	30 seconds
Heater: Voltage	6.3 volts
Current	0.8 ampere
Typical Output Power (Load VSWR = 1.15:1)	75 milliwatts
Frequency Range	9200 to 10,000 megacycles

MECHANICAL

Operating Position	Any
Mounting	UG-39/U waveguide flange
Cooling	Conduction
Electrical Connections	Flexible leads
R-F Output Coupling	RG-52/U waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.40 inches
Width	1.63 inches
Length	2.28 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-Operating Shock (11 ms Duration)	40 g
Maximum Operating Shock* (11 ms Duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.

**Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	350 MAX. VOLTS
D-C CATHODE CURRENT	55 MAX. MA.
RESONATOR DISSIPATION	20 MAX. WATTS
PEAK REPELLER VOLTAGE*	
POSITIVE WITH RESPECT TO CATHODE	0 MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	300	350	volts
Mode	5¾	5¾	
Frequency	9600	9600	megacycles
D-C Cathode Current	40	50	milliamperes
D-C Repeller Voltage*	−170	−155	volts
D-C Repeller Current	1	1	microampere
Power Output	70	90	milliwatts
Electronic Tuning (3 db bandwidth)	35	35	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	1.7	1.7	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	50	50	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for D-C isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XK is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

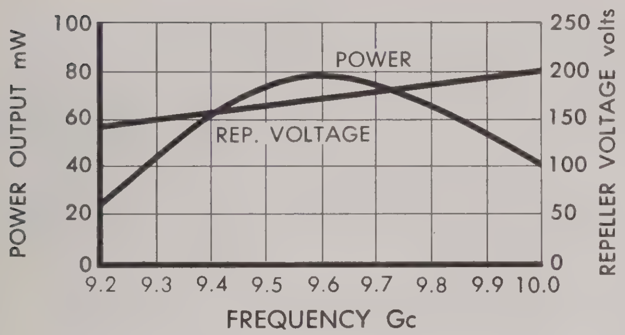
The heater and cathode of the 1K20XK are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

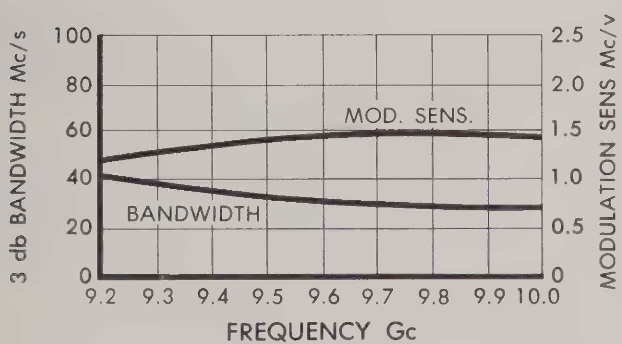
Mechanical Tuning: In the 1K20XK a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

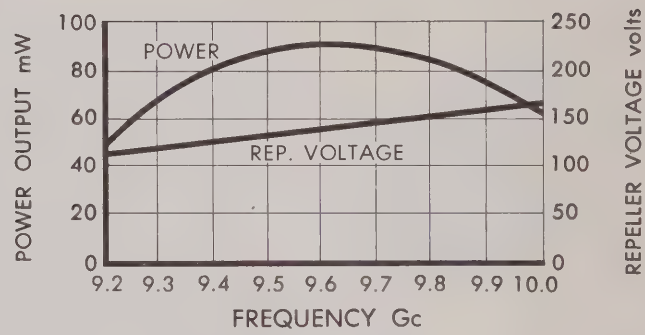
IK20XK TYPICAL OPERATING CHARACTERISTICS

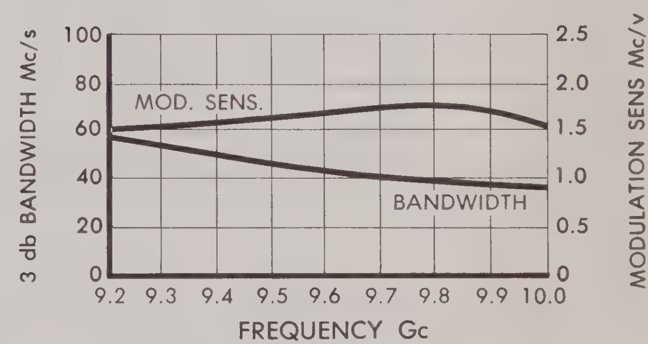
E_{RS} = 350 Vdc
I_K = 50 mAdc
5¾ MODE



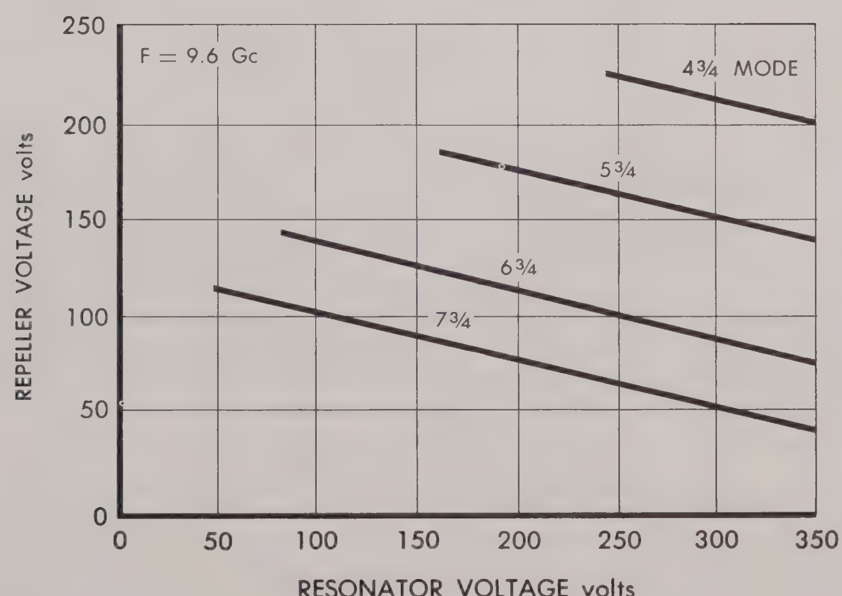


E_{RS} = 300 Vdc
I_K = 40 mAdc
5¾ MODE

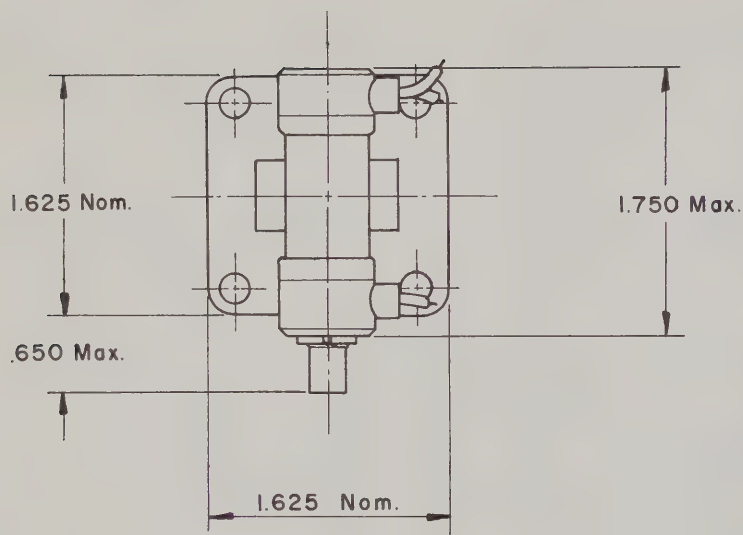




MODE CHARACTERISTICS



1K20 XK

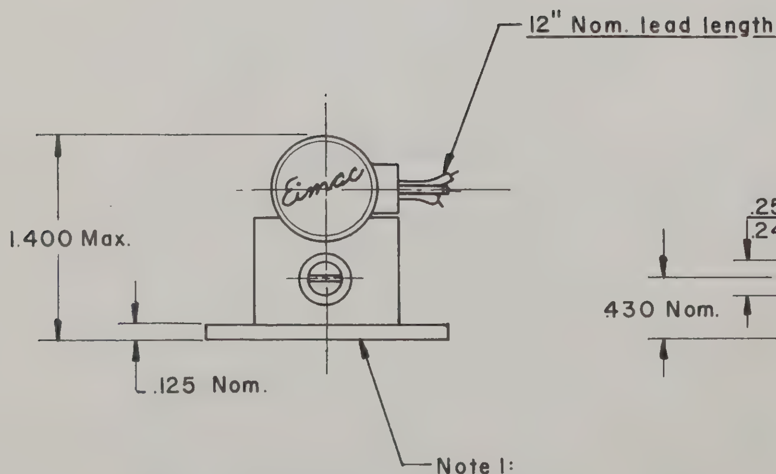


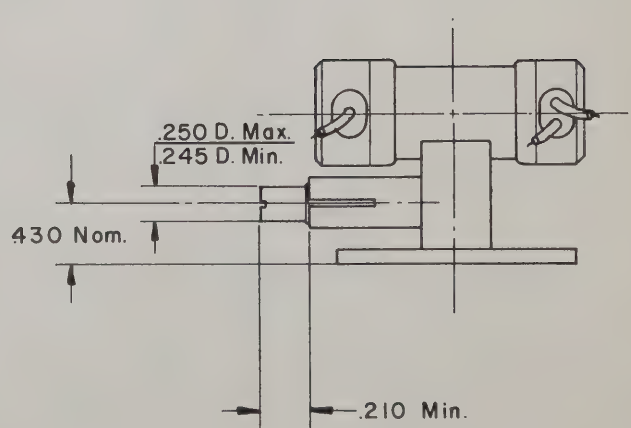
NOTE:

1. Mates with UG-39/U flange for RG-52/U waveguide

CONNECTIONS

1. REPELLER - RED
2. CATHODE - BLACK
3. HEATER - WHITE



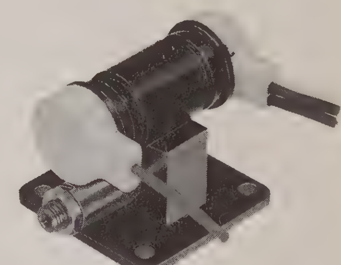


EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

TENTATIVE DATA

1K20XN-A

X-BAND REFLEX KLYSTRON



The Eimac 1K20XN-A is a ceramic and metal reflex klystron which is especially well-suited for parametric amplifier pump applications. This tube is available at any factory pre-set frequency between 8.5 and 11.0 Gc, and the lock-tuner can be trimmed ± 50 Mc. for fine tuning adjustments.

The 1K20XN-A provides a minimum output power of 150 milliwatts and is conservatively warranteed for 1,000 hours.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated		
	Warm-up Time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Connections			flexible leads

MECHANICAL

Operating Position	any	
Mounting	UG-39/U Waveguide flange	
RF Output Coupling	RG-52/U Waveguide	
Net Weight	4	ounces
Shipping Weight (approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.50	inches
Width	1.63	inches
Length	2.50	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150°	C
Maximum Altitude	no limit	
Maximum Shock* (11 ms duration)	40	g
Maximum Operating Vibration** (20-2,000 cps)	10	g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 200 kilocycles.

TYPICAL OPERATION

Mode	4-3/4	
Frequency	10.6	Gc
Resonator Voltage	400	Vdc
Output Power	200	MW
Cathode Current	40	mAdc

TYPICAL OPERATION (continued)

Repeller Voltage*	-290	Vdc
3 db Bandwidth	25	Mc
Modulation Sensitivity	0.8	Mc/V

*All voltages referred to cathode.

MAXIMUM RATINGS

Resonator Voltage	450	Vdc
Cathode Current	50	mAdc
Repeller Voltage	500	Vdc
Ambient Temperature	150°	C
Resonator Dissipation with conduction cooling	20	watts
Resonator Dissipation with forced air cooling	30	watts

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150° C. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175° Centigrade.

Resonator: The resonator of the 1K20XN-A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the 1K20XN-A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

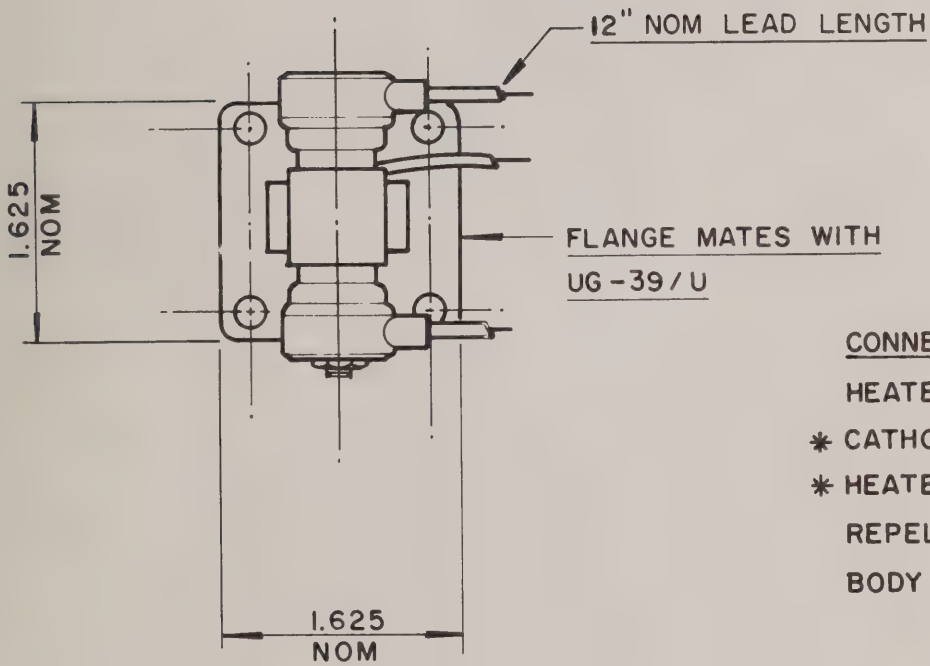
Mechanical Trimming: The 1K20XN-A is fitted with a locking tuner that allows ±50 mc trimming. The center frequency is factory pre-set to your specification.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2,000 cps) or shock of up to 40g (11 milliseconds duration).

With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 200 kilocycles.

Special Applications: For additional information regarding any specific application, write to Microwave Division, Eitel-McCullough, Inc., San Carlos, California, telephone Lytell 1-1451, Cable EIMAC.

1K20XN-A



CONNECTIONS

HEATER - WHITE

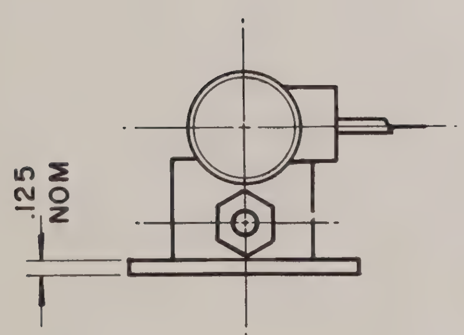
* CATHODE - BLACK

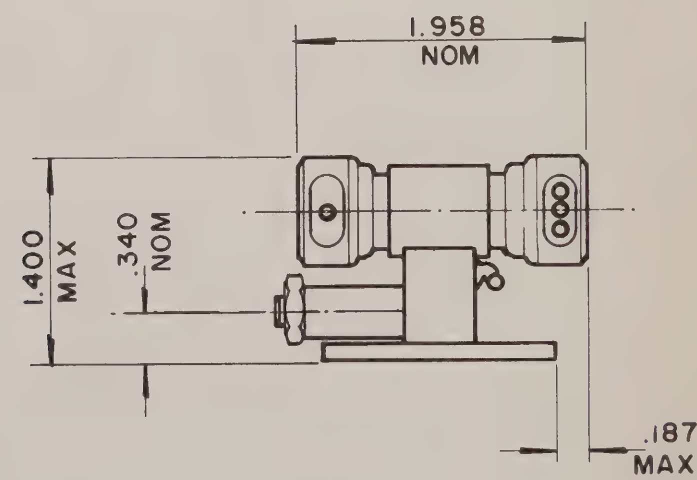
* HEATER - BLACK

REPELLER - RED

BODY — BLACK-WHITE

* INTERNALLY CONNECTED





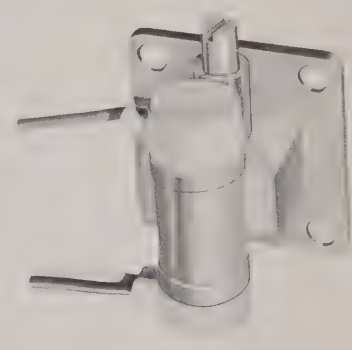
EITEL-McCULLOUGH, INC.

TENTATIVE DATA

1K20XS

X-BAND

REFLEX KLYSTRON



The Eimac 1K20XS is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 8500 to 9200 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated.	
Warm-up time	30 seconds
Heater: Voltage	6.3 volts
Current	0.8 ampere
Typical Output Power (Load VSWR = 1.15:1)	75 milliwatts
Frequency Range	8500 to 9200 megacycles

MECHANICAL

Operating Position	Any
Mounting	UG-39/U waveguide flange
Cooling	Conduction
Electrical Connections	Flexible leads
R-F Output Coupling	RG-52/U waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.40 inches
Width	1.63 inches
Length	2.28 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-Operating Shock (11 ms Duration)	40 g
Maximum Operating Shock* (11 ms Duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	350 MAX. VOLTS
D-C CATHODE CURRENT	55 MAX. MA.
RESONATOR DISSIPATION	20 MAX. WATTS
PEAK REPELLER VOLTAGE*	
POSITIVE WITH RESPECT TO CATHODE	0 MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage	350	300	volts
Mode	5¾	5¾	
Frequency	8850	8850	megacycles
D-C Cathode Current	50	40	milliamperes
D-C Repeller Voltage*	135	150	volts
D-C Repeller Current	1	1	microampere
Power Output	90	70	milliwatts
Electronic Tuning (3 db bandwidth)	40	40	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	1.5	1.5	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	50	50	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for D-C isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XS is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

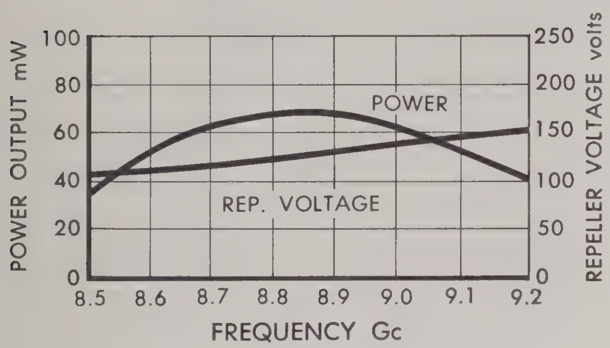
The heater and cathode of the 1K20XS are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

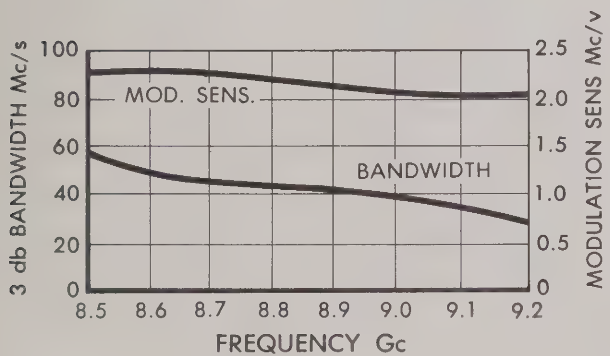
Mechanical Tuning: In the 1K20XS a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

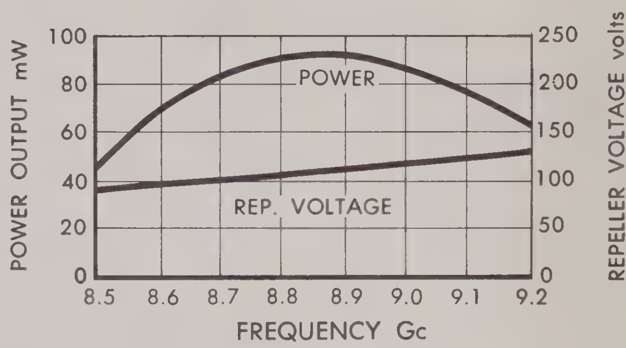
IK20XS TYPICAL OPERATING CHARACTERISTICS

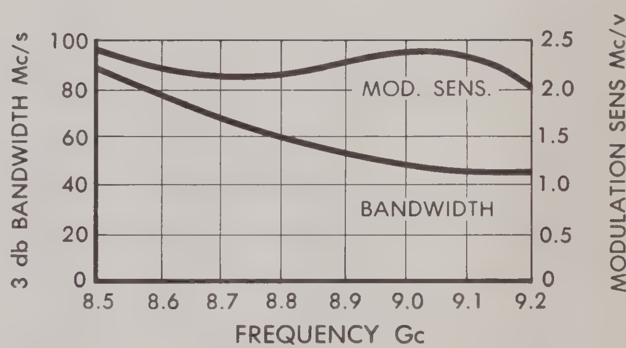
E_{RS} = 300 Vdc
I_K = 40 mAdc
5¾ MODE



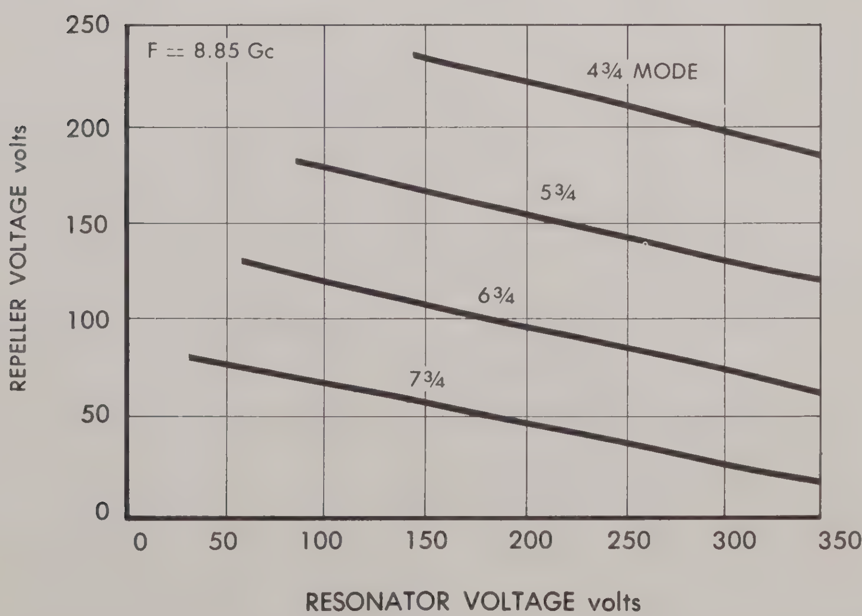


E_{RS} = 350 Vdc
I_K = 50 mAdc
5¾ MODE

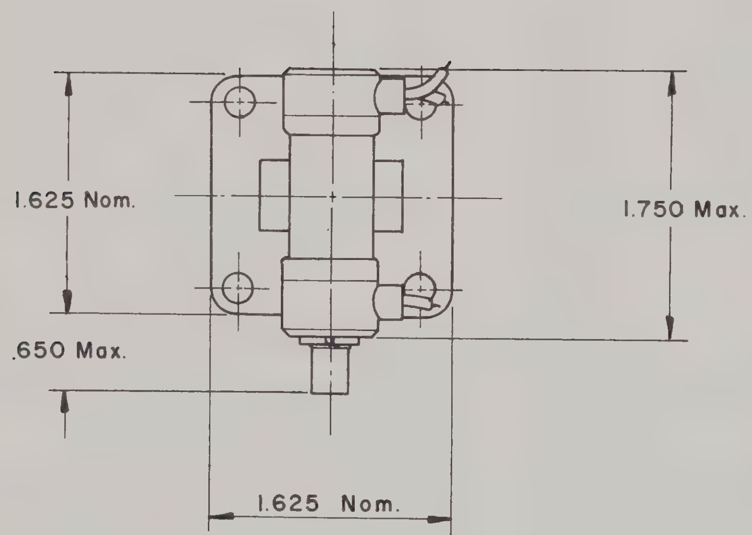




MODE CHARACTERISTICS



1K20XS

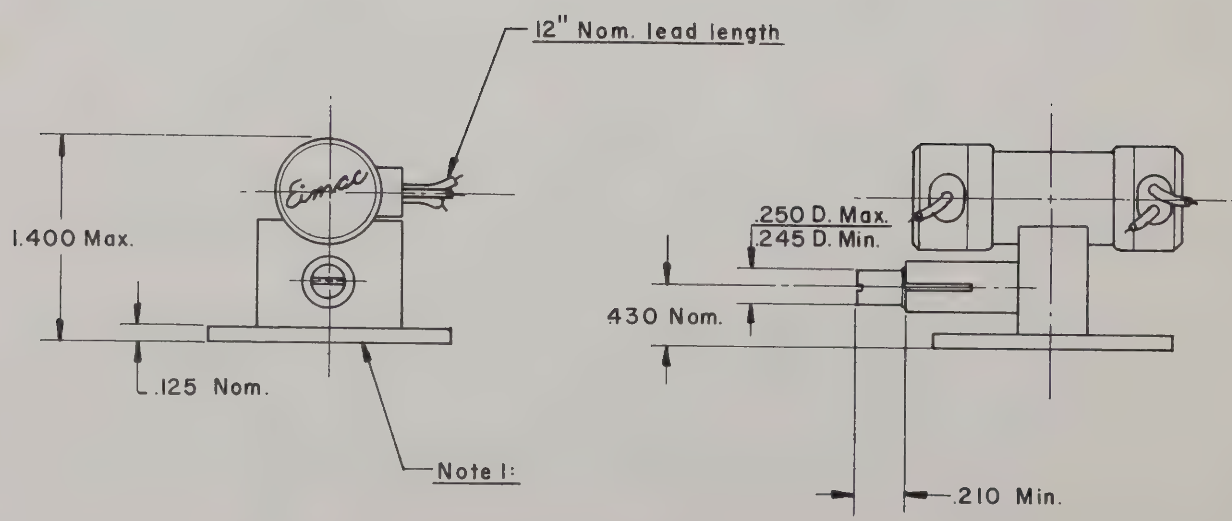


NOTE:

1. Mates with UG-39/U flange for RG-52/U waveguide

CONNECTIONS

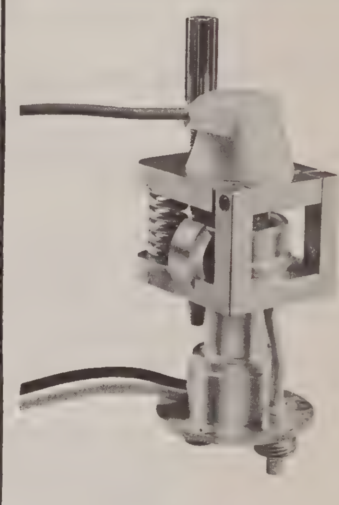
1. REPELLER - RED
2. CATHODE - BLACK
3. HEATER - WHITE



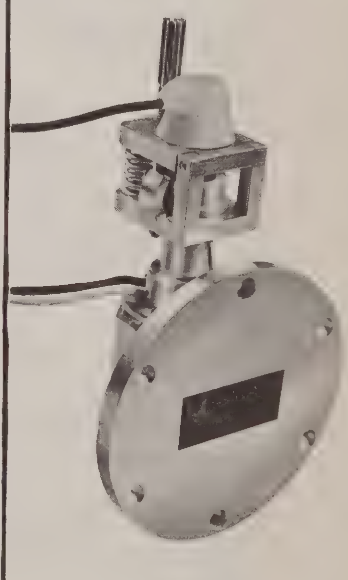
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

PRELIMINARY DATA
1K015CA
1K015CG
C-BAND
REFLEX KLYSTRONS

The Eimac 1K015CA and 1K015CG are ceramic and metal, ruggedized, internal-cavity reflex klystrons designed for local oscillator service in the frequency range of 5350 to 5950 megacycles. These tubes are capable of delivering a minimum output power of 70 milliwatts into a load VSWR of 1.5 to 1 under conditions of shock, vibration or sustained acceleration.



1K015CA



1K015CG

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated.		
	Warm-up time - -	60	seconds
Heater:	Voltage - - -	6.3	volts
	Current - - -	1.0	ampere
Minimum Output Power (Load VSWR=1.5:1)		70	milliwatts
Frequency Range - -		5350 to 5950	megacycles

MECHANICAL

Operating Position - - - -			Any
Mounting:			
1K015CA - - -			Three hole flange
1K015CG - -			UG-344/U waveguide flange
R-F Output Coupling:			
1K015CA - -			Miniature coaxial fitting
1K015CG - -			RG-50/U waveguide
Electrical Connections - -			Flexible leads
Cooling - - -			Convection and conduction
Maximum Overall Dimensions:	<u>1K015CA</u>	<u>1K015CG</u>	
Length - -	3.4	5.3	inches
Width - -	1.3	3.1	inches
Depth - -	1.2	1.5	inches
Net Weight - - -	4.2	17.5	ounces
Shipping Weight (Approximate)	2	6	pounds

ENVIRONMENTAL

Maximum Ambient Temperature - - - -	100° C
Maximum Altitude - - - - - -	No limit
Maximum Operating Shock (11 ms duration)* - -	40 g
Maximum Operating Vibration (20-2000 cps)** - -	10 g

*Based on a maximum permanent frequency shift after drop of 1.5 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 1.0 megacycle.

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE*	350	MAX. VOLTS
D-C CATHODE CURRENT	55	MAX. MA.
RESONATOR DISSIPATION	20	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	300	350	volts
Mode	4-3/4	3-3/4	
Frequency	5650	5650	megacycles
D-C Cathode Current	35	49	milliamperes
D-C Repeller Voltage*	-135	-240	volts
D-C Repeller Current	1	1	microampere
Power Output	35	130	milliwatts
Electronic Tuning Range (3 db-bandwidth)	45	45	megacycles
Modulation Sensitivity	1600	900	Kc/volt
Peak-to-peak FM Deviation (10g, 20-2000 cps)	75	75	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level, these tubes will not require forced air cooling when operated at their maximum rated dissipation with an ambient temperature less than 100° Centigrade. The mounting flange or waveguide flange will normally provide the required heat sink connection for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 200° Centigrade.

Resonator: The resonator of the 1K015CA and 1K015CG is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variation in performance is to be minimized and best tube life obtained.

The heater and cathode of the 1K015CA and 1K015CG are internally connected. When the resonator of these tubes is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: Mechanical tuning is accomplished by a single screw tuner with a differential thread. A tuning rate of approximately 100 megacycles per turn and a maximum tuner torque of four inch-pounds is provided by this design. Mechanical stops, capable of withstanding a maximum torque of 10 inch-pounds, are provided at the extremes of the tuning range. Tuner cycling in excess of 100 cycles will not damage the vacuum seals.

A clockwise rotation of the tuner will produce an increase in frequency.

Mounting: The 1K015CA should be mounted by the three-hole tube flange provided. The 1K015CG is mounted by the UG-344/U waveguide flange to the appropriate waveguide connector.

Electrical connections are made to both tubes by means of the flexible leads provided.

Output Coupling: The R-F terminal of the 1K015CA is a miniature coaxial connector described in detail in the outline drawing. For waveguide coupling, the 1K015CG utilizes the Eimac transition section and mates with standard RG-50/U waveguide. An adapter is available on special order to adapt the 1K015CA to standard BNC type coaxial output.

Special Applications: For additional information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

Eitel-McCullough, Inc.
February 16, 1960
AE245

EITEL-McCULLOUGH, INC.

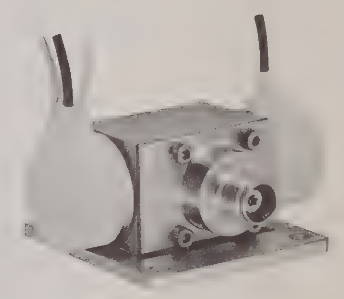
TENTATIVE DATA

1K75CH
1K75CK

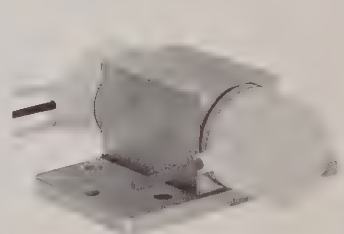
C-BAND

REFLEX KLYSTRONS

The Eimac 1K75CH and 1K75CK are low noise, ceramic and metal, ruggedized, internal cavity, reflex klystrons designed for use in altimeter applications at a fixed frequency of 4300 ± 50 megacycles. These conduction-cooled tubes are capable of delivering a minimum output power of one watt into a load VSWR of 1.15 to 1 under conditions of severe shock, vibration or acceleration extremes.



1K75CH



1K75CK

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time - -	60	seconds
Heater:	Voltage - - -	6.3	volts
	Current - -	1.0 to 1.5	amperes
Minimum Output Power (Load VSWR=1.15:1)		1.0	watts
Operating Frequency - -		4300 ± 50	megacycles

MECHANICAL

Operating Position - - -				Any
Mounting:				
1K75CH - - -				Heat sink flange
1K75CK - -				Special waveguide flange
R-F Output Coupling:				
1K75CH - - -				Insulated TNC jack
1K75CK -				Special half-height waveguide
Electrical Connections - -				Flexible leads
Cooling - - -				Convection and conduction
Maximum Overall Dimensions:	1K75CH	1K75CK		
Depth - -	1.13	1.19	inches	
Width - -	2.50	2.76	inches	
Length - -	2.51	2.73	inches	
Net Weight - -	8.5	8.0	ounces	
Shipping Weight (Approximate)	2	2	pounds	

ENVIRONMENTAL

Maximum Heat-Sink or Ambient Temperature - -	125° Centigrade
Maximum Altitude (1K75CK, and 1K75CH with TNC jack at body potential) - - - -	No Limit
Maximum Altitude (1K75CH with TNC jack at cathode potential)	40,000 Feet
Maximum Non-Operating Shock (11 ms duration) (1K75CH) -	15 g
Maximum Non-Operating Shock (11 ms duration) (1K75CK) -	30 g
Maximum Operating Vibration (20-2000 cps)* - - -	10 g

*Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE*	850	MAX. VOLTS
D-C CATHODE CURRENT	100	MAX. MA.
RESONATOR DISSIPATION	75	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500	MAX. VOLTS
PEAK HEATER TO CATHODE VOLTAGE	±45	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	550	750	volts
Mode	4-3/4	2-3/4	
Frequency	4300	4300	megacycles
D-C Cathode Current	35	60	milliamperes
D-C Repeller Voltage*	-150	-350	volts
D-C Repeller Current	1	1	microampere
Power Output	0.25	1.0	watt
Electronic Tuning (3 db bandwidth)	60	30	megacycles
Modulation Sensitivity (ΔE_r = ± 5 volts)	1600	160	Kc/volt
Residual FM	40	40	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade.

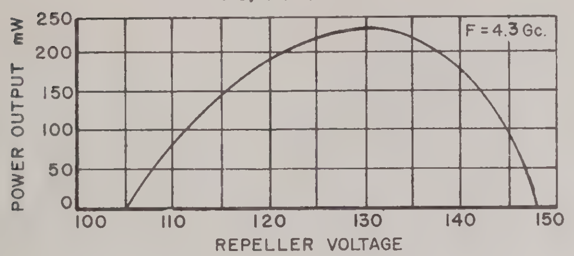
Resonator: The resonator of the 1K75C series tubes is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

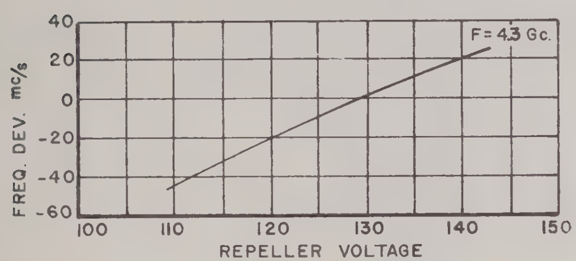
Cathode: The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed ± 45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

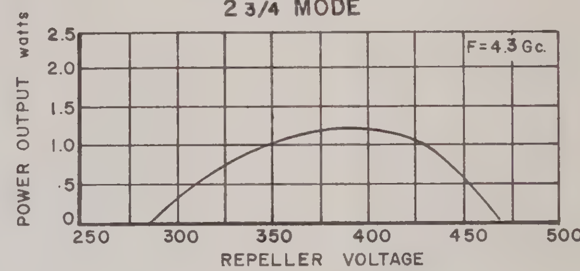
IK75CH/CK TYPICAL OPERATING CHARACTERISTICS

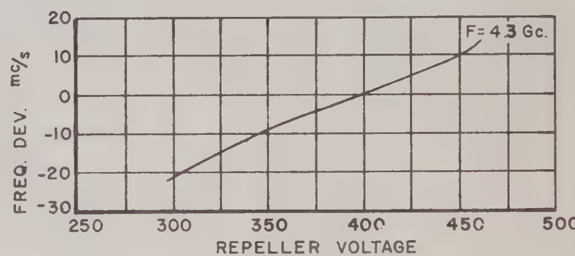
ERS = 500 Vdc
I_K = 35 mAdc
4 3/4 MODE



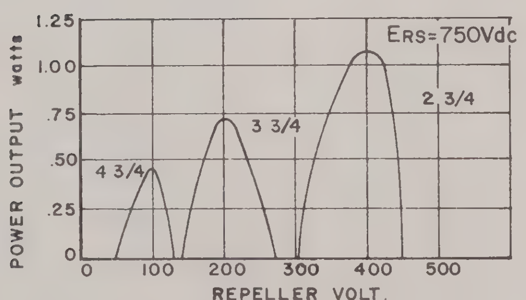


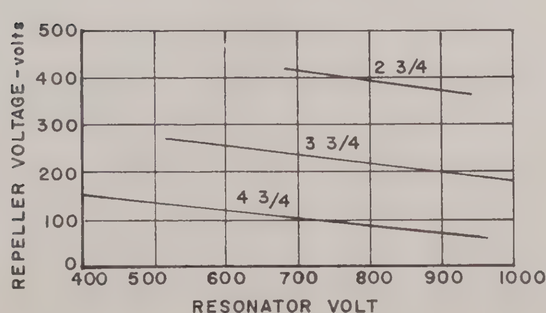
ERS = 750 Vdc
I_K = 60 mAdc
2 3/4 MODE



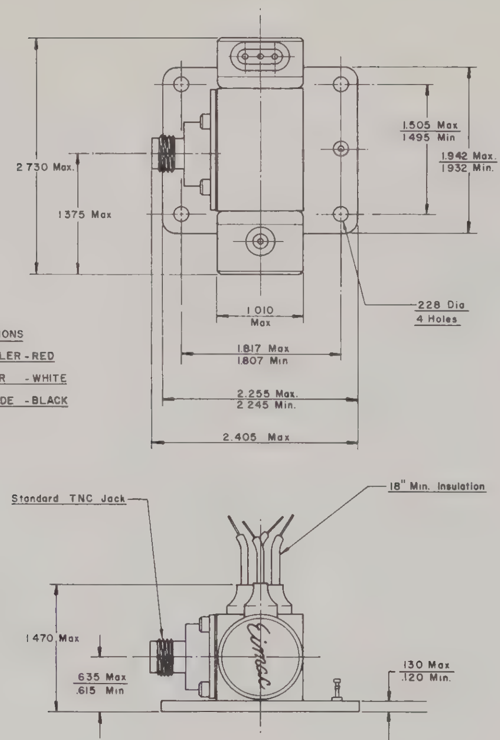


MODE CHARACTERISTICS



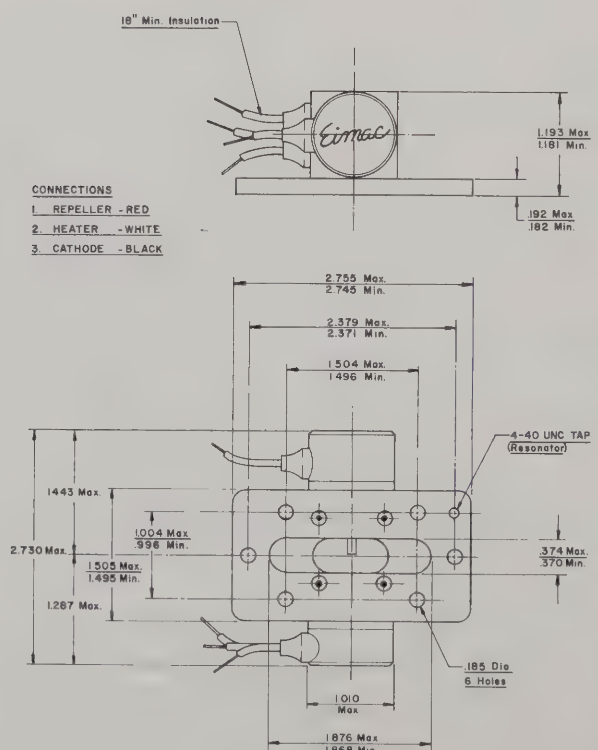


1K75 CH



CONNECTIONS
1. REPELLER - RED
2. HEATER - WHITE
3. CATHODE - BLACK

1K75 CK



CONNECTIONS
1. REPELLER - RED
2. HEATER - WHITE
3. CATHODE - BLACK

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K75CS

C-BAND REFLEX KLYSTRON

The Eimac 1K75CS is intended to ease the system designers' logistics and performance problems by providing a ruggedized, load-insensitive reflex klystron/isolator package for the 4200-4400 Mc. radio-altimeter band. Combining these two components into one integral package allows them to be matched for optimum performance. Operating in the 4-3/4 mode, the 1K75CS provides more than 300 mW and 100 Mc. electronic tuning range into a load VSWR of 2:1 with only 8 Mc. maximum frequency pulling. Alternately, this tube can be factory pre-set to provide approximately 1 watt and 30 Mc. electronic tuning range.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time	60	seconds
Heater:	Voltage	6.3	volts
	Current	1.0 to 1.5	amperes
Minimum Output Power (4-3/4 mode)		0.3	watts
Operating Frequency (Fixed)		4300 ± 50	megacycles

MECHANICAL

Operating Position		Any
Mounting		Heat Sink Flange
RF Output Coupling		Special Half-Height Waveguide
Electrical Connections		Flexible Leads
Maximum Overall Dimensions:		
Depth	4.16	Inches
Width	2.81	Inches
Length	2.76	Inches
Net Weight	1.5	Pounds Max.
Shipping Weight (Approximate)	3	Pounds

ENVIRONMENTAL

Maximum Heat-Sink Temperature	125°C
Maximum Non-Operating Shock (11 ms Duration)	15 g
Maximum Operating Vibration (20 - 1500 cps)*	10 g

*Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE	900 MAX. VOLTS
DC CATHODE CURRENT	85 MAX. MA
RESONATOR DISSIPATION	75 MAX. WATTS
PEAK REPELLER VOLTAGE*	
POSITIVE WITH RESPECT TO CATHODE	0 MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX. VOLTS

TYPICAL OPERATION

Mode	4-3/4	
Frequency	4300	megacycles
DC Resonator Voltage*	700	volts
DC Cathode Current	55	milliamperes
DC Repeller Voltage	-85	
DC Repeller Current	1	microampere
Output Power	325	milliwatts
Electronic Tuning (3 db bandwidth)	110	megacycles
Modulation Sensitivity	3	Mc/volt
Residual FM	40	kilocycles
Temperature Coefficient (-55 to +125 C)	±75	Kc/°C

*Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

APPLICATION

Cooling: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

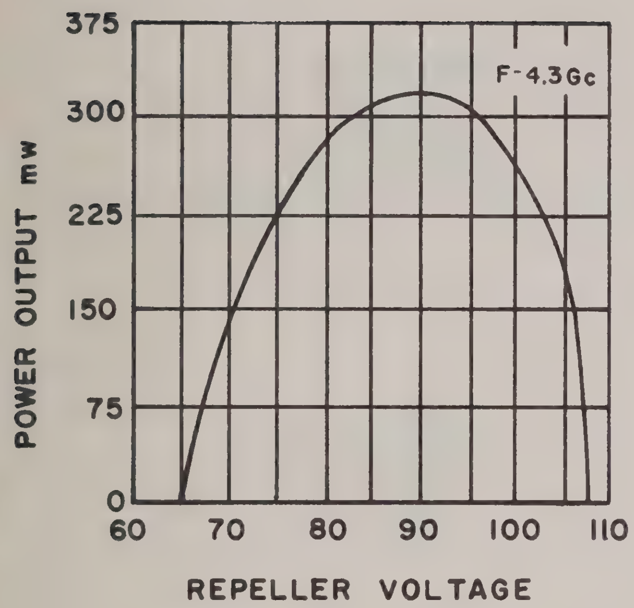
Resonator: The resonator of the 1K75CS is integral with the body of the tube. For this reason, it is convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

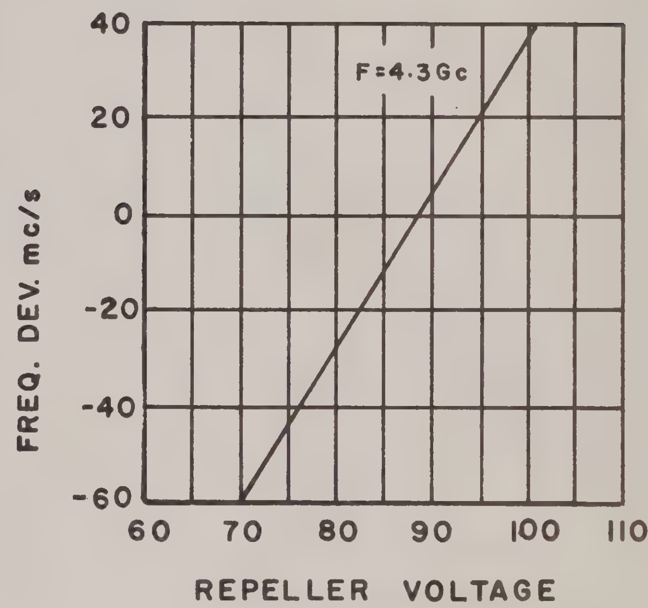
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

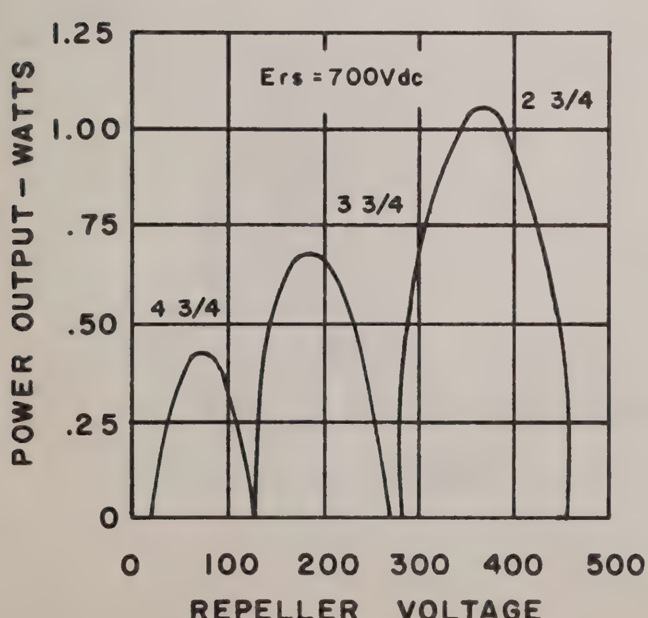
1K75CS TYPICAL OPERATING CHARACTERISTICS

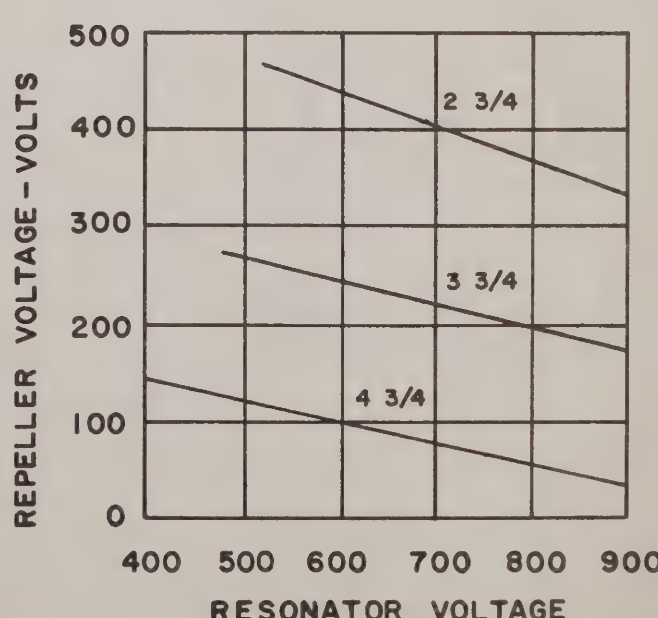
Ers = 700 Vdc
Ik = 55 mAdc
4 3/4 MODE



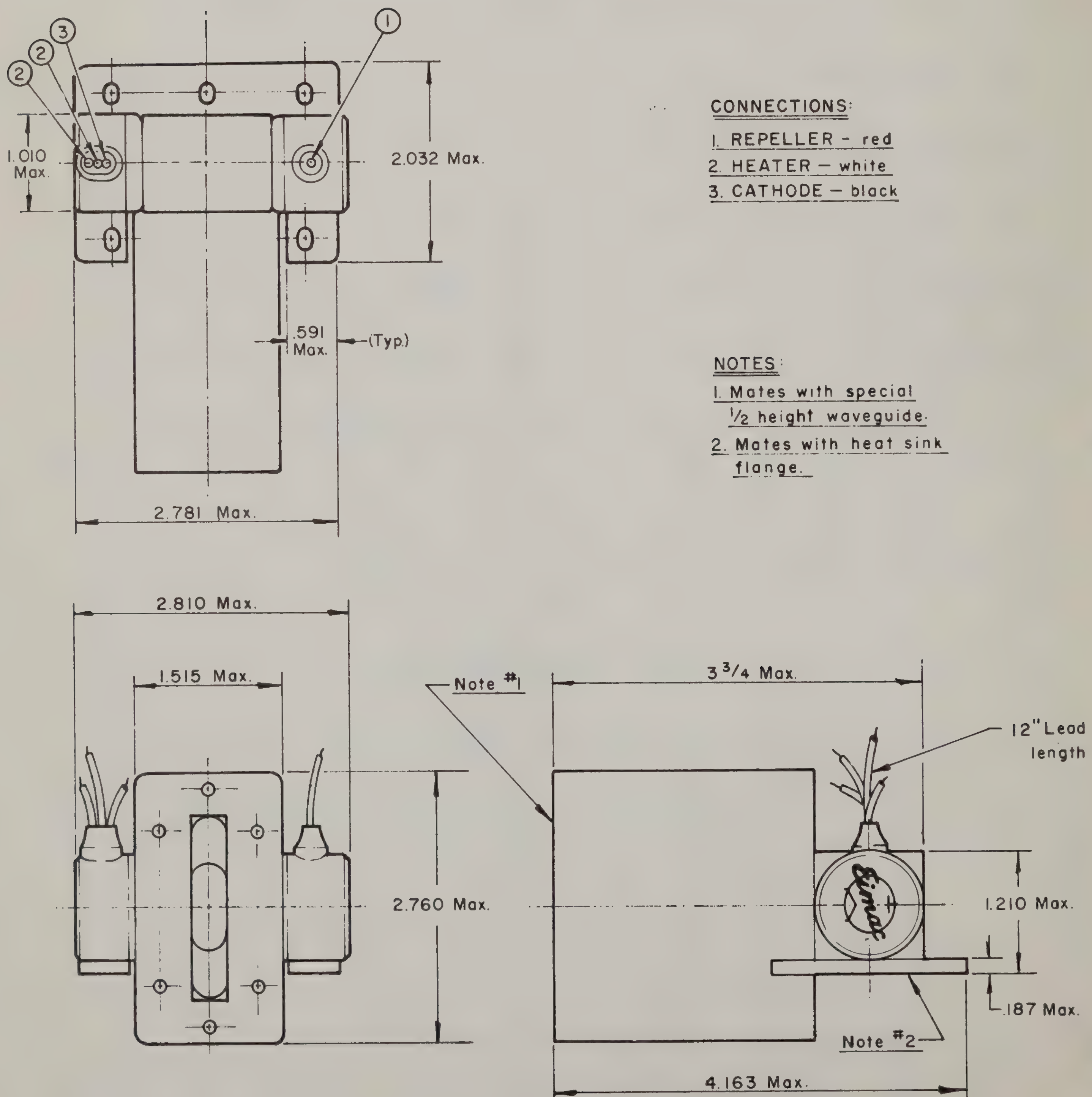


MODE CHARACTERISTICS





1K75 CS



CONNECTIONS:

1. REPELLER - red
2. HEATER - white
3. CATHODE - black

NOTES:

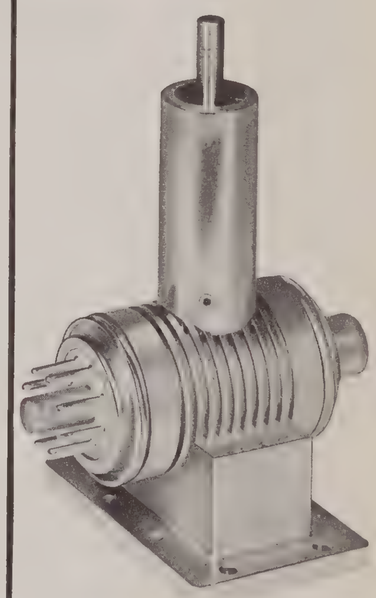
1. Mates with special ½ height waveguide.
2. Mates with heat sink flange.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K125CB

C-BAND
REFLEX KLYSTRON



The Eimac 1K125CB is a low-noise, ceramic and metal, forced-air cooled, reflex klystron designed for use in communication service in the frequency range of 4400 to 5000 megacycles. When operated on the 2-3/4 mode as a driver or transmitter, it will deliver a minimum CW output power of 1.8 watts into a load VSWR of 1.15 to 1 throughout the band specified.

A low-loss ceramic slug tuner, coupled by a bellows to an external tuning shaft, allows repeated mechanical tuning without damage. The non-contacting dielectric tuner provides a tuning rate of approximately 100 megacycles per turn.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	60	seconds
Heater:	Voltage	6.3	volts
	Current	1.0 to 1.5	amperes
Minimum Output Power (Load VSWR=1.15:1)		1.8	watts
Frequency Range		4400 to 5000	megacycles

MECHANICAL

Operating Position	Any
Mounting	CMR-187 waveguide flange
R-F Output Coupling	WR-187 (RG-49/U) waveguide
Base	Octal, ceramic
Socket	Standard octal
Cooling	Forced air
Nominal Tuner Starting Torque	3 inch-ounces
Net Weight	18 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Length	4.35 inches
Width	2.80 inches
Depth	3.32 inches

ENVIRONMENTAL

Maximum Altitude	10,000 feet
Maximum Non-Operating Shock (1 ms duration)	80 g
Maximum Non-Operating Vibration (40 cps, 120 sec.)	10 g

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE*	1000	MAX. VOLTS
D-C CATHODE CURRENT	110	MAX. MA.
RESONATOR DISSIPATION	125	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	750	MAX. VOLTS
PEAK HEATER TO CATHODE VOLTAGE	±45	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	800	1000	volts
Mode	3-3/4	2-3/4	
Frequency	4700	4700	megacycles
D-C Cathode Current	54	75	milliamperes
D-C Repeller Voltage*	-130	-345	volts
D-C Repeller Current	2	2	microamperes
Power Output	.77	2.5	watts
Electronic Tuning (3 db bandwidth)	50	32	megacycles
Modulation Sensitivity ($\triangle E_r$ = ±5 volts)	700	295	Kc/volt
Residual FM	10	10	kilocycles
Linearity***($\triangle F$ = ±2 Mc)	-42	-45	db

*All voltages referred to cathode.
**Level of second harmonic below fundamental modulating frequency.

APPLICATION

Cooling: At sea level, with an ambient temperature of 50° Centigrade, a minimum air flow rate of 10 CFM, directed over the klystron body, is required to adequately cool the tube when operated at maximum ratings.

For conditions other than the above, the criterion for proper cooling is to maintain the klystron ceramic-to-metal seal temperatures below 175° Centigrade. Cooling in excess of the minimum recommended flow rate will result in longer tube life and more stable operation. If extended tube life is of primary concern, the body temperature should not exceed 100° Centigrade.

Resonator: The resonator of the 1K125CB is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

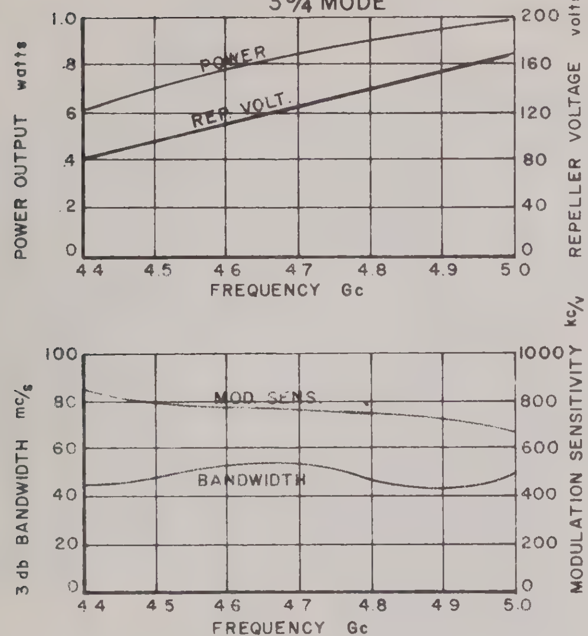
The heater and cathode of the 1K125CB are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Electrical connection to the cathode of this tube should be completed by utilizing all four of the cathode base pins.

1K125 CB TYPICAL OPERATING CHARACTERISTICS

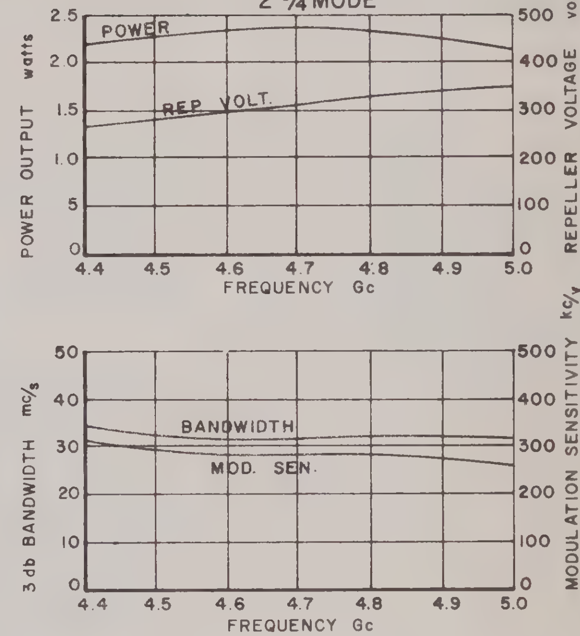
E_{RS}=800 Vdc
I_K=54 mAdc

3 3/4 MODE

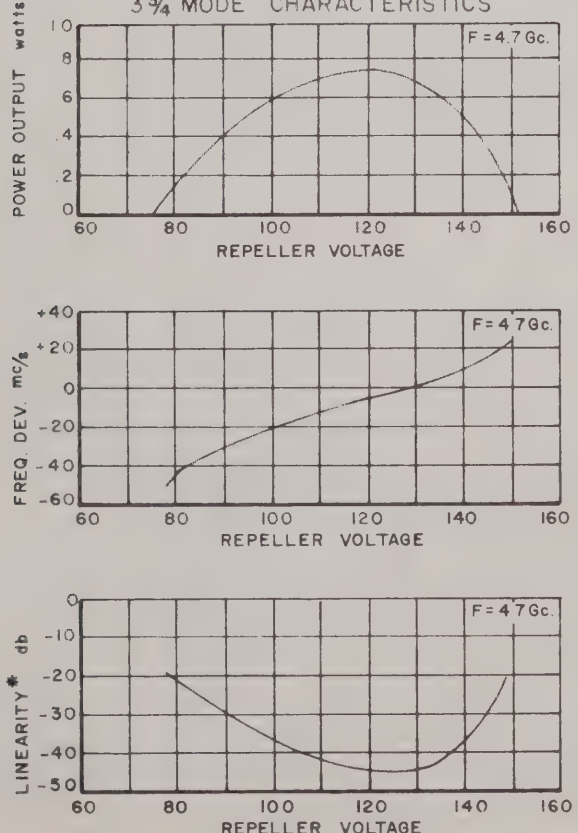


E_{RS}=1000 Vdc
I_K = 75 mAdc

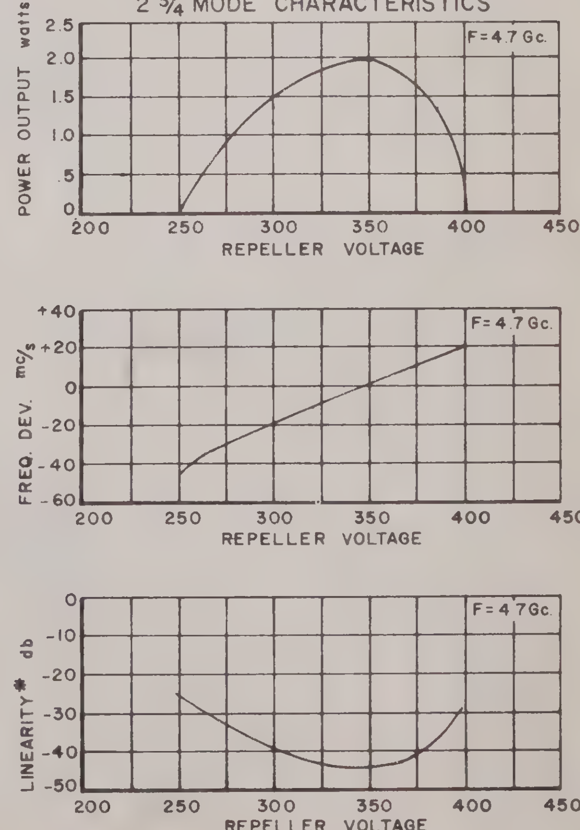
2 3/4 MODE



3 3/4 MODE CHARACTERISTICS



2 3/4 MODE CHARACTERISTICS



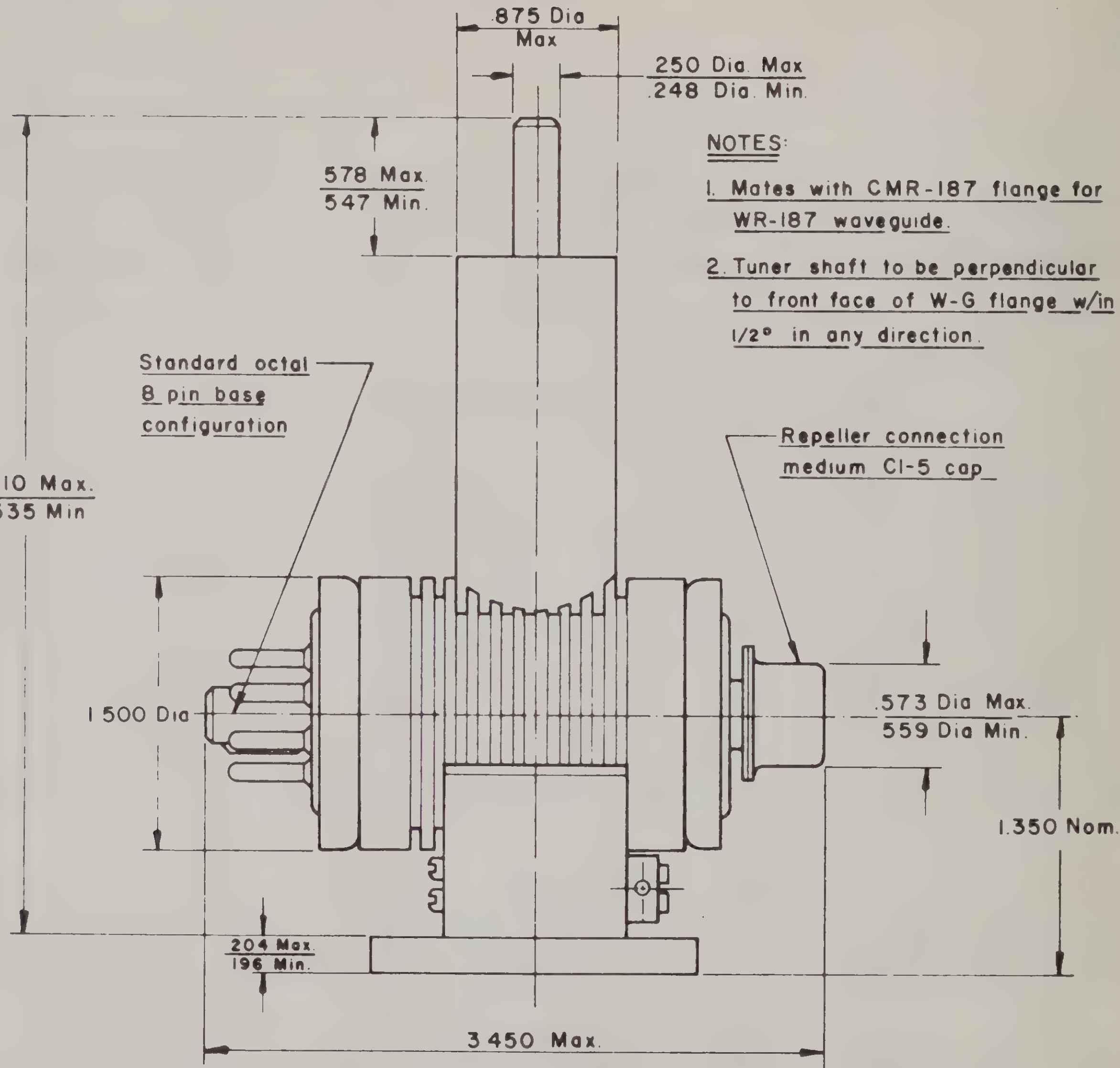
* LEVEL OF SECOND HARMONIC BELOW THE FUNDAMENTAL MODULATING FREQUENCY WITH A FREQUENCY DEVIATION OF ± 2 Mc.

1K125 CB

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

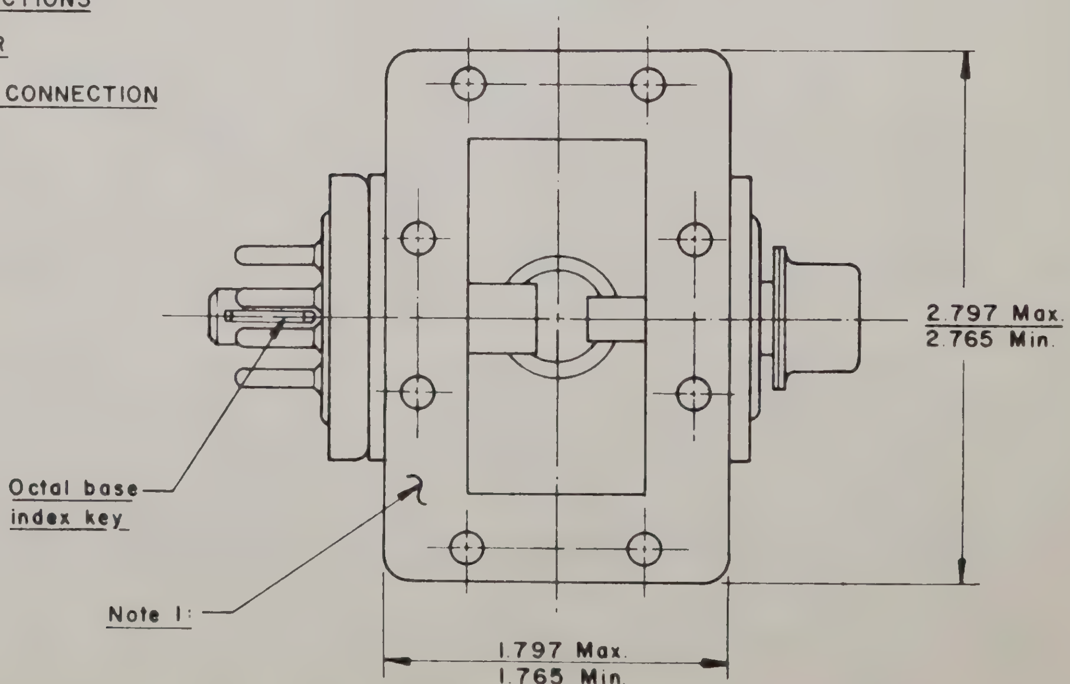
NOTES:

1. Mates with CMR-187 flange for WR-187 waveguide.
2. Tuner shaft to be perpendicular to front face of W-G flange w/in 1/2° in any direction.



BASE CONNECTIONS

1. RESONATOR
2. INTERNAL CONNECTION
3. CATHODE
4. CATHODE
5. HEATER
6. HEATER
7. CATHODE
8. CATHODE

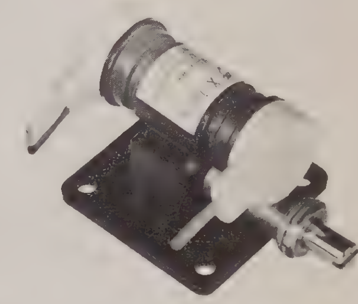


EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X-1075

X-BAND REFLEX KLYSTRON



The Eimac X-1075 is a ceramic and metal, conduction cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 30 milliwatts over the frequency range of 8500 to 9600 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

FEATURES: This tube features Eimac's new long-life tuner which renders excellent torque control under extreme environmental conditions over as many as 10,000 cycles.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time	30	seconds
Heater:	Voltage	6.3	volts
	Current	1.0	ampere
Typical Output Power (Load VSWR = 1.15:1)		30	milliwatts
Frequency Range		8500 to 9600	megacycles

MECHANICAL

Operating Position			Any
Mounting			UG-39/U Waveguide Flange
Cooling			Conduction
Electrical Connections			Flexible Leads
RF Output Coupling			RG-52/U Waveguide
Net Weight		4	Ounces
Shipping Weight (Approximate)		2	Pounds
Maximum Overall Dimensions:			
	Height	1.40	Inches
	Width	1.63	Inches
	Length	2.28	Inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C	
Maximum Altitude	No Limit	
Maximum Non-Operating Shock (11 ms Duration)	40	g
Maximum Operating Shock (11 ms Duration)	40	g
Maximum Operating Vibration (20 to 2000 cps)	10	g

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	400 MAX.	VOLTS
DC CATHODE CURRENT	40 MAX.	MA
RESONATOR DISSIPATION	20 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

OPERATION

	MIN.	AVE.	MAX.	UNIT
Mode	---	6-3/4	---	
Frequency	8.5	---	9.6	Gc.
DC Resonator Voltage	---	250	---	Volts
DC Cathode Current	20	---	30	ma
DC Repeller Voltage	---	65	---	Volts
DC Repeller Current	---	---	1	μamp
Power Output	20	30	50	mW
Electronic Tuning (3 db bandwidth)	---	35	---	mc
Modulation Sensitivity	---	---	2	mc
Peak-to-Peak FM Deviation (10g, 20 - 2000 cps)			250	kc
Residual FM	---	---	50	kc

*All voltages referred to cathode.

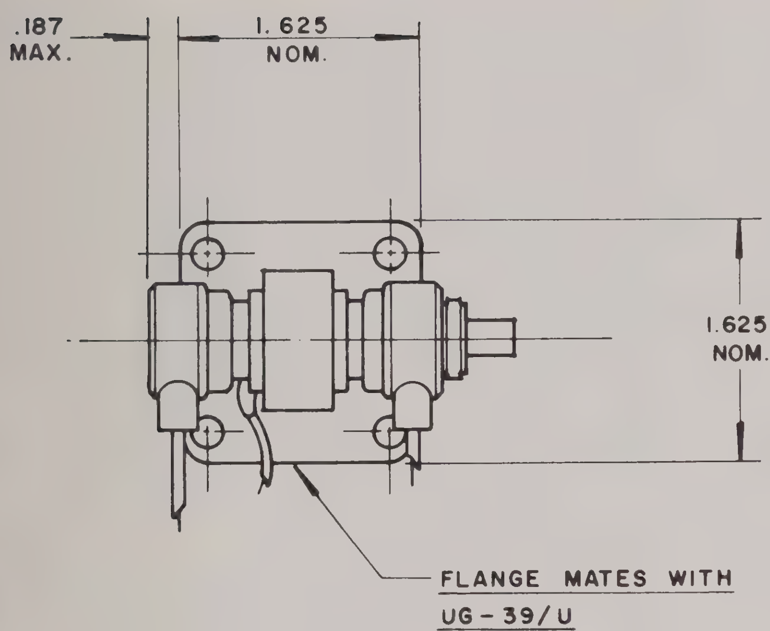
APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with am ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade. Maximum life will be obtained if the tube is maintained at 150° C or less.

Resonator: The resonator of the X-1075 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

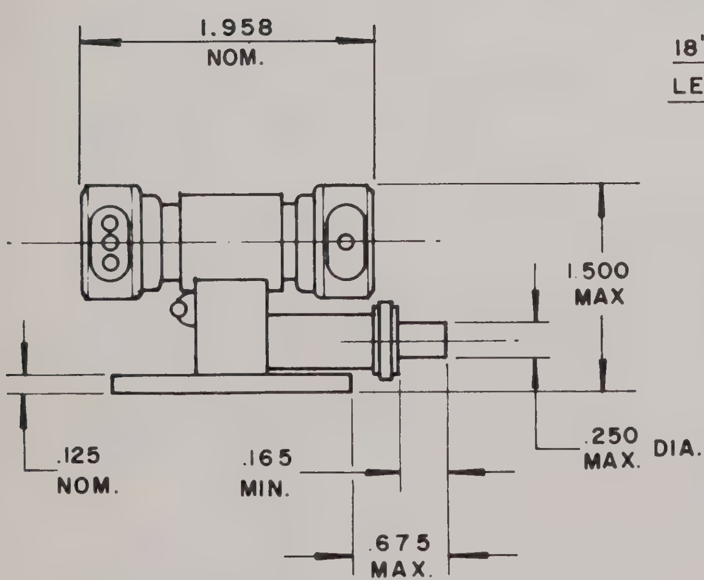
The heater and cathode of the X-1075 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

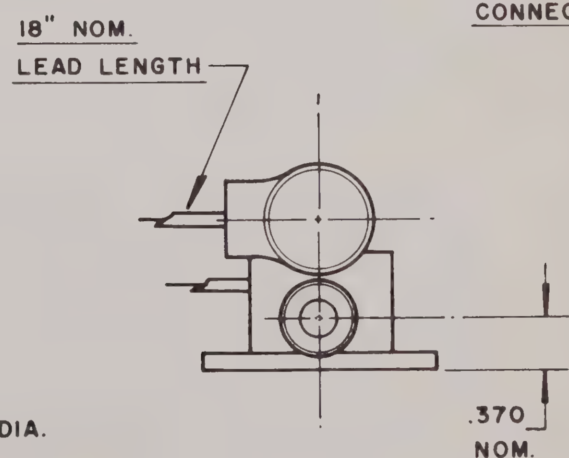


LEAD CONNECTIONS

YELLOW	HEATER
* GREEN	CATHODE
* WHITE	HEATER
GRAY	REFLECTOR
BROWN	BODY

* INTERNALLY CONNECTED

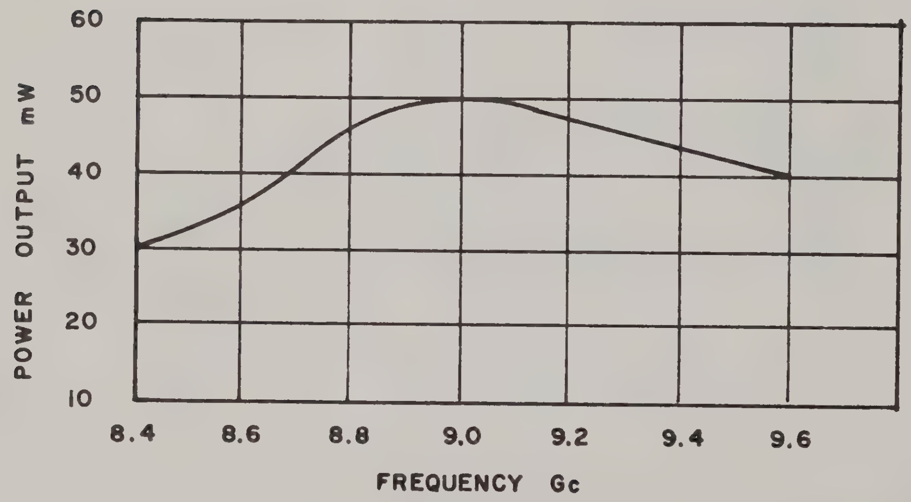


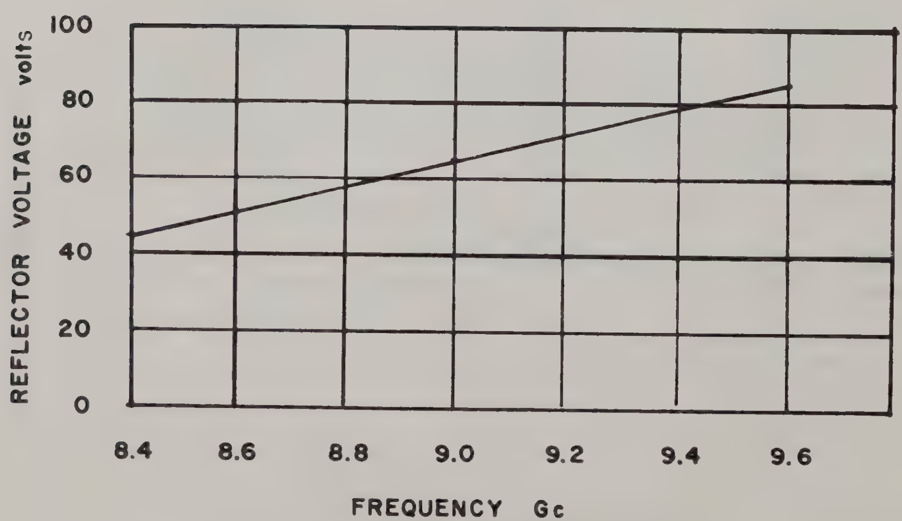


X 1075

X1075 OPERATING CHARACTERISTICS

Ers = 250 Vdc
Ik = 22 mA dc
$6\frac{3}{4}$ MODE





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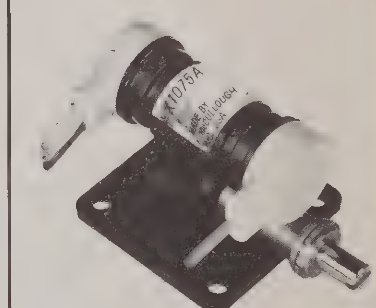
SAN CARLOS CALIFORNIA

TENTATIVE DATA

X-1075A

X-BAND REFLEX KLYSTRON



The Eimac X-1075A is a ceramic and metal, conduction cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 100 milliwatts over the frequency range of 8500 to 9600 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

FEATURES: This tube features Eimac's new long-life tuner which renders excellent torque control under extreme environmental conditions over as many as 10,000 cycles.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time	30	seconds
Heater:	Voltage	6.3	volts
	Current	1.0	ampere
Typical Output Power (Load VSWR = 1.15:1)		100	milliwatts
Frequency Range		8500 to 9600	megacycles

MECHANICAL

Operating Position		Any
Mounting		UG-39/U Waveguide Flange
Cooling		Conduction
Electrical Connections		Flexible Leads
RF Output Coupling		RG-52/U Waveguide
Net Weight	4	Ounces
Shipping Weight (Approximate)	2	Pounds
Maximum Overall Dimensions:		
Height	1.40	Inches
Width	1.63	Inches
Length	2.28	Inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C	
Maximum Altitude	No Limit	
Maximum Non-Operating Shock (11 ms Duration)	40	g
Maximum Operating Shock (11 ms Duration)	40	g
Maximum Operating Vibration (20 to 2000 cps)	10	g

(Effective 8-10-62)

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	500 MAX.	VOLTS
DC CATHODE CURRENT	50 MAX.	MA
RESONATOR DISSIPATION	25 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

OPERATION

	MIN.	AVE.	MAX.	UNIT
Mode	---	5-3/4	---	
Frequency	8.5	---	9.6	Gc.
DC Resonator Voltage	---	400	---	Volts
DC Cathode Current	---	40	---	ma
DC Repeller Current	---	---	1	μamp
Power Output	100	130	200	mW
Electronic Tuning (3 db bandwidth)	---	30	---	mc
Modulation Sensitivity	---	---	2	Mc/Volt
Peak-to-Peak FM Deviation (10g, 20 - 2000 cps)			250	kc
Residual FM	---	---	50	kc

*All voltages referred to cathode.

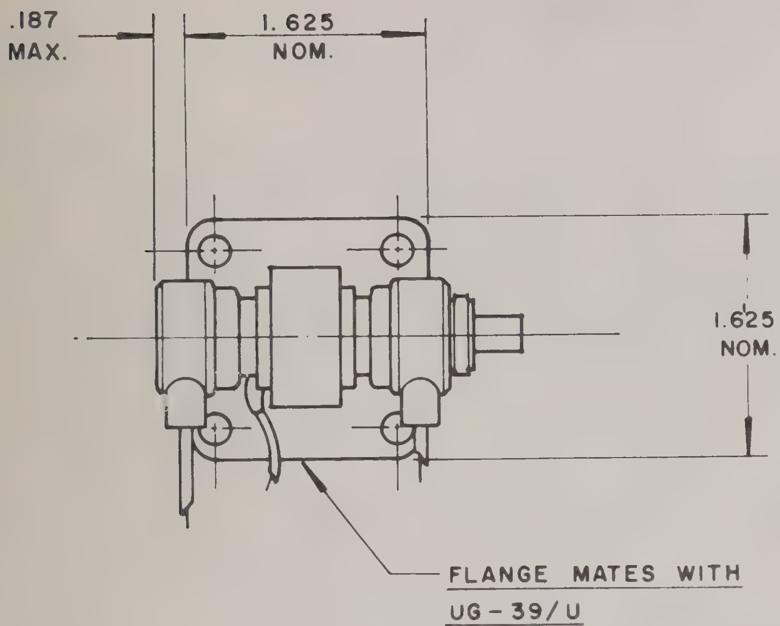
APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade. Maximum life will be obtained if the tube is maintained at 150° C or less.

Resonator: The resonator of the X-1075A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within $\pm$ 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

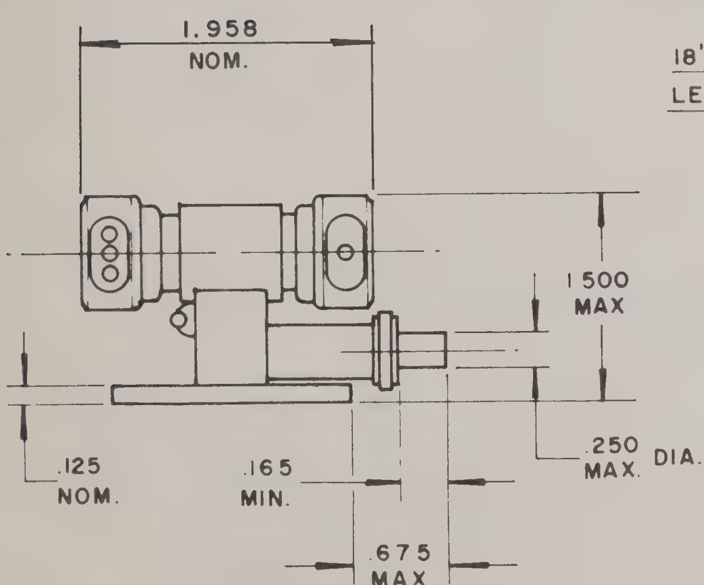
The heater and cathode of the X-1075A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

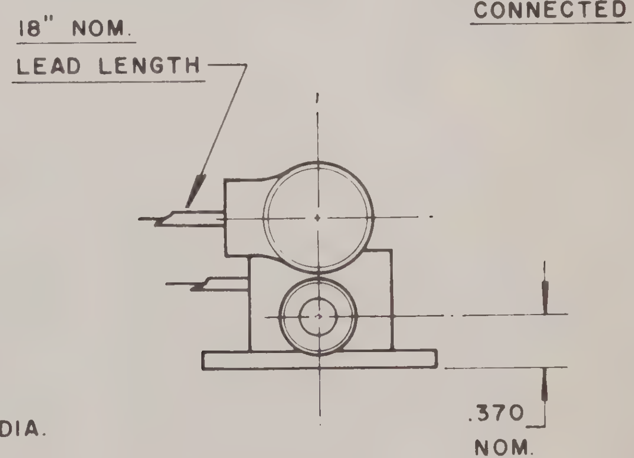


LEAD CONNECTIONS

YELLOW	HEATER
* GREEN	CATHODE
* WHITE	HEATER
GRAY	REFLECTOR
BROWN	BODY

* INTERNALLY CONNECTED

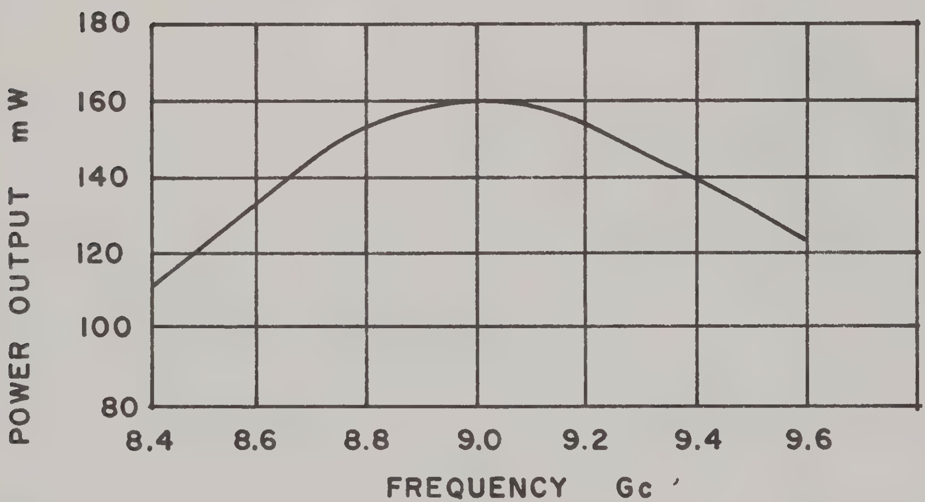


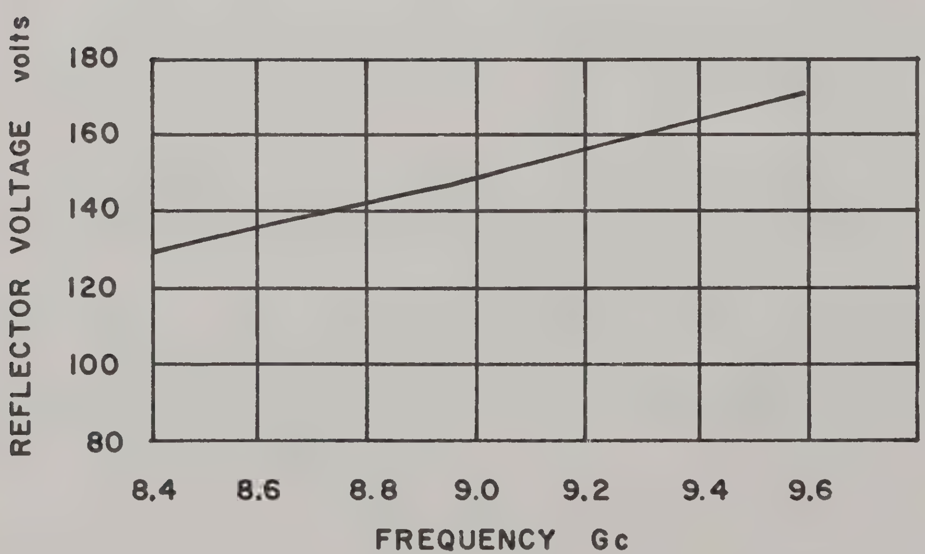


X 1075 A

X 1075A OPERATING CHARACTERISTICS

E rs = 400 V dc
I k = 40 mA dc
5 3/4 MODE





EITEL-McCULLOUGH, INC.

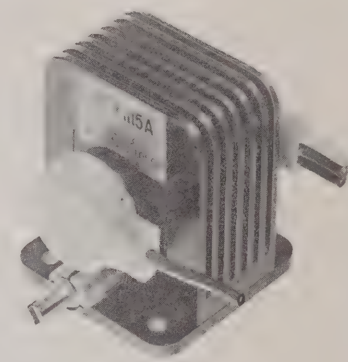
TENTATIVE DATA

X1115A

REFLEX KLYSTRON

The Eimac X1115A is a ceramic and metal, conduction-cooled reflex klystron designed for transmitter/local oscillator service in 12.2 - 12.7 Gc. microwave relay equipments. This tube provides a minimum output power of 100 mW and is tunable across the entire 500 Mc. band. High power output and good power/frequency stability also make the X1115A a good choice for parametric amplifier pump applications.

The X1115A features low-noise gridless gun optics and is warranteed for 1000 hours life.



GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		100	milliwatts
Frequency Range		12.200 to 12.700	megacycles

MECHANICAL

Operating Position	Any	
Mounting	WR-75 Waveguide Flange	
Cooling	Conduction	
Electrical Connections	Flexible Leads	
RF Output Coupling	WR-75 Waveguide	
Net Weight	4	ounces
Shipping Weight (Approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.8	inches
Width	1.5	inches
Length	2.5	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-operating Shock (11 ms duration)	40 g
Maximum Operating Shock* (11 ms duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.

**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	500	MAX. VOLTS
DC CATHODE CURRENT	60	MAX. MA
RESONATOR DISSIPATION	30	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	(25	MAX. VOLTS)
NEGATIVE WITH RESPECT TO CATHODE	(500	MAX. VOLTS)

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	400	volts
Mode		4-3/4
Frequency	12,450	megacycles
DC Cathode Current	40	milliamperes
DC Repeller Voltage*	-200	volts
DC Repeller Current	1	microampere
Power Output	150	milliwatts
Electronic Tuning (3 db bandwidth)	30	megacycles
Modulation Sensitivity ($E_r = \pm 3$ volts)	2.0	Mc/volt
Peak-to-peak FM Deviation (10 g, 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1115A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

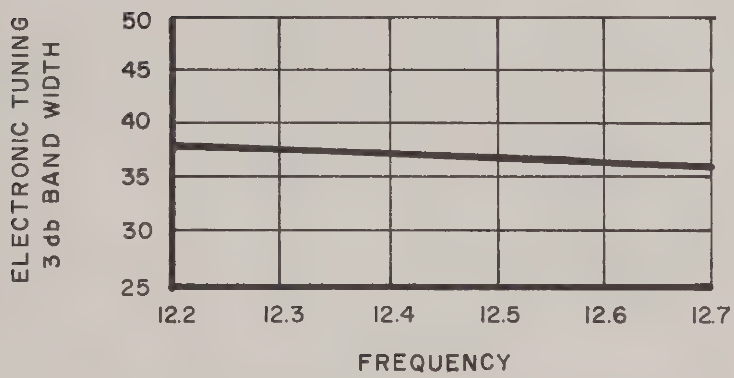
The heater and cathode of the X1115A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

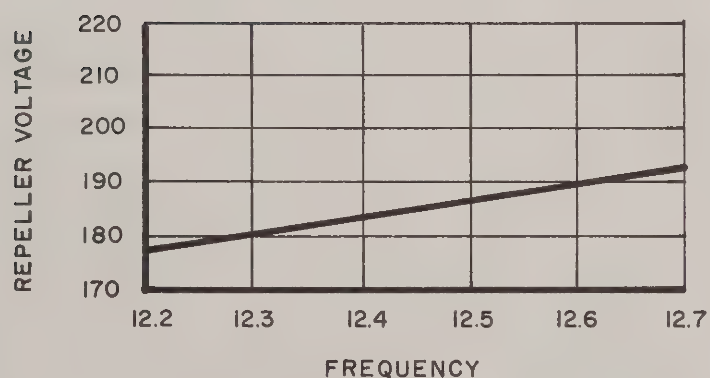
Mechanical Tuning: In the X1115A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

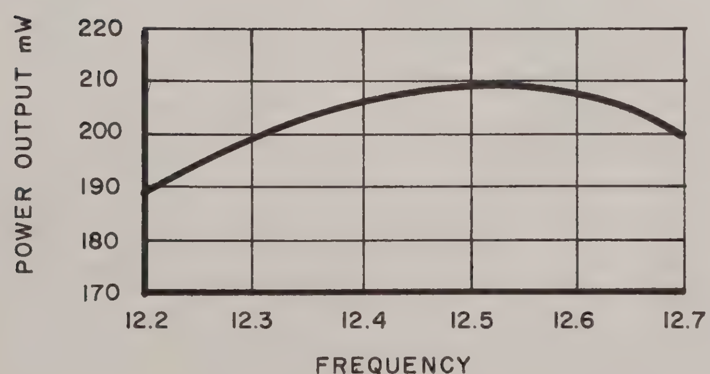
A clockwise rotation of the tuner will produce a decrease in frequency.

X1115A OPERATING CHARACTERISTICS

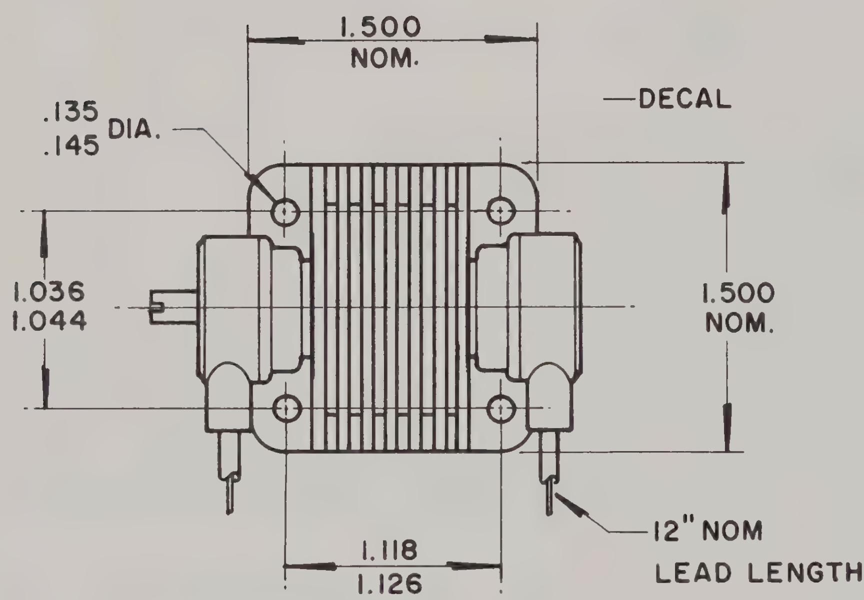
Ers = 400 V.
$5\frac{3}{4}$ MODE







X1115A



CONNECTIONS

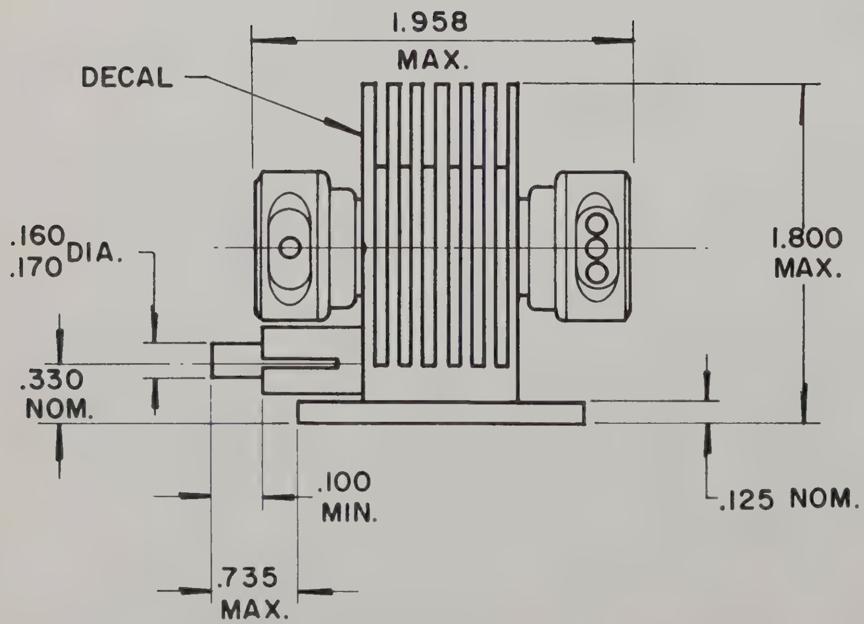
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

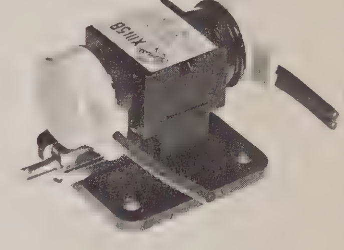
TENTATIVE DATA

X1115B

REFLEX KLYSTRON

The Eimac X1115B is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in 12.2 - 12.7 Gc. microwave relay equipments. The tube provides a minimum power output of 30 mW and is tunable across the entire 500 Mc. band.

The X1115B features low-noise gridless gun construction, good power and frequency stability and is conservatively warranteed for 1000 hours life.



GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		30	milliwatts
Frequency Range		12,200 to 12,700	megacycles

MECHANICAL

Operating Position	Any
Mounting	WR-75 Waveguide Flange
Cooling	Conduction
Electrical Connections	Flexible Leads
RF Output Coupling	WR-75 Waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.4 inches
Width	1.5 inches
Length	2.5 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-operating Shock (11 ms duration)	40 g
Maximum Operating Shock* (11 ms duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	425	MAX. VOLTS
DC CATHODE CURRENT	45	MAX. MA
RESONATOR DISSIPATION	20	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	400	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	300	volts
Mode		6-3/4
Frequency	12,450	megacycles
DC Cathode Current	26	milliamperes
DC Repeller Voltage*	-130	volts
DC Repeller Current	1	microampere
Power Output	40	milliwatts
Electronic Tuning (3 db bandwidth)	35	megacycles
Modulation Sensitivity ($E_r = \pm 3$ volts)	2.5	Mc/volt
Peak-to-peak FM Deviation (10 g, 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1115B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

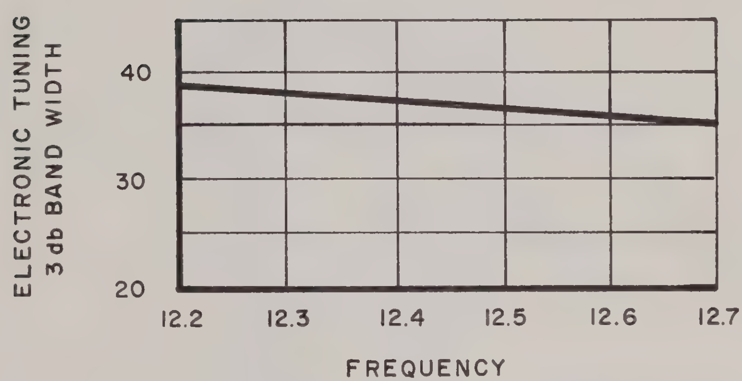
The heater and cathode of the X1115B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

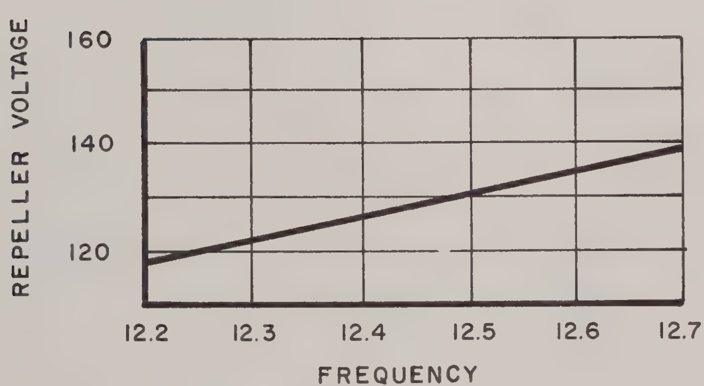
Mechanical Tuning: In the X1115B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

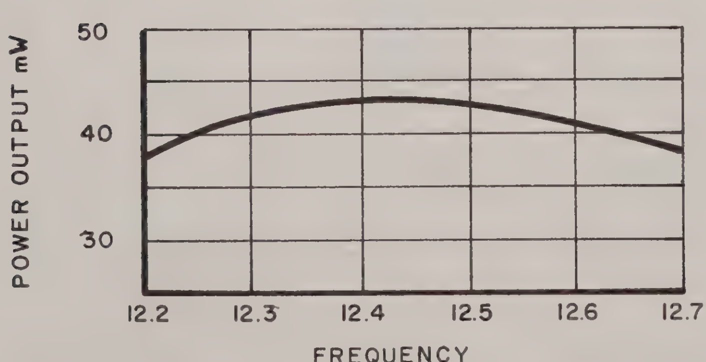
A clockwise rotation of the tuner will produce a decrease in frequency.

X1115B OPERATING CHARACTERISTICS

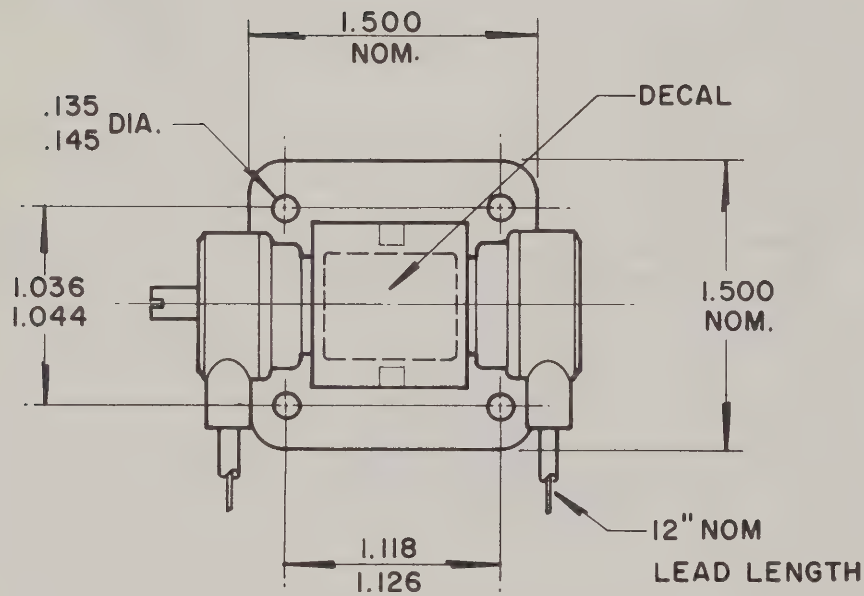
Ers = 300 V.
$6\frac{3}{4}$ MODE







X1115B



CONNECTIONS

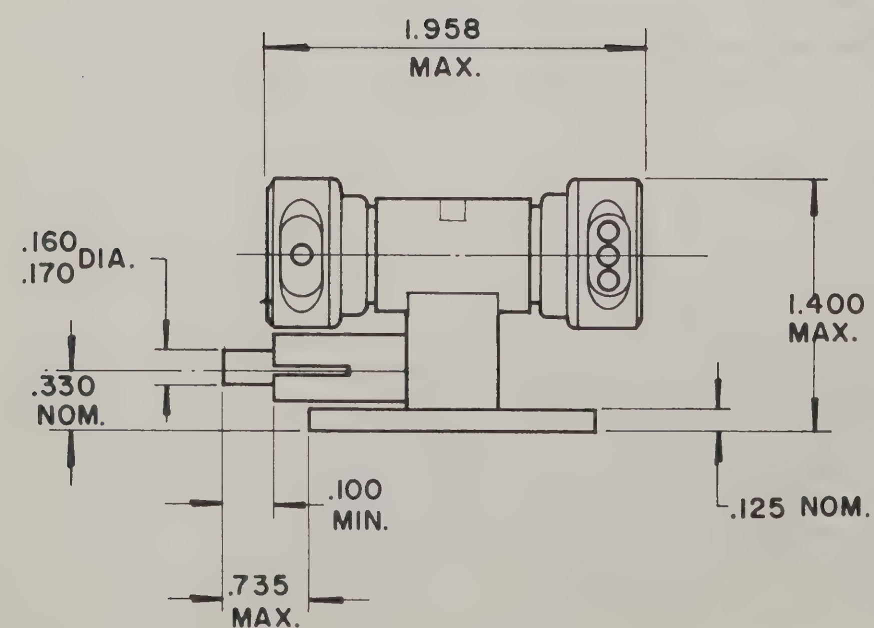
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED



EITEL-McCULLOUGH, INC.

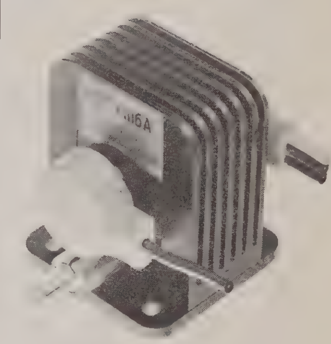
TENTATIVE DATA

X1116A

REFLEX KLYSTRON

The Eimac X1116A is a ceramic and metal. conduction-cooled reflex klystron designed for transmitter/local oscillator service in 11.7 - 12.2 Gc. microwave relay equipments. This tube provides a minimum output power of 100 mW and is tunable across the entire 500 Mc. band. High power output and good power/frequency stability also make the X1116A a good choice for parametric amplifier pump applications.

The X1116A features low-noise gridless gun optics and is warranteed for 1000 hours life.



GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		100	milliwatts
Frequency Range		11.700 to 12.200	megacycles

MECHANICAL

Operating Position	Any
Mounting	WR-75 Waveguide Flange
Cooling	Conduction
Electrical Connections	Flexible Leads
RF Output Coupling	WR-75 Waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.8 inches
Width	1.5 inches
Length	2.5 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-operating Shock (11 ms duration)	40 g
Maximum Operating Shock* (11 ms duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	500	MAX. VOLTS
DC CATHODE CURRENT	60	MAX. MA
RESONATOR DISSIPATION	30	MAX. WATTS
PEAK REPELLER VOLTAGE*		
NEGATIVE WITH RESPECT TO CATHODE	(25	MAX. VOLTS)
	(500	MAX. VOLTS)

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	400	volts
Mode		4-3/4
Frequency	11.950	megacycles
DC Cathode Current	40	milliamperes
DC Repeller Voltage*	-200	volts
DC Repeller Current	1	microampere
Power Output	150	milliwatts
Electronic Tuning (3 db bandwidth)	30	megacycles
Modulation Sensitivity ($E_r = \pm 3$ volts)	2.0	Mc/volt
Peak-to-peak FM Deviation (10 g. 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation. forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1116A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential. with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

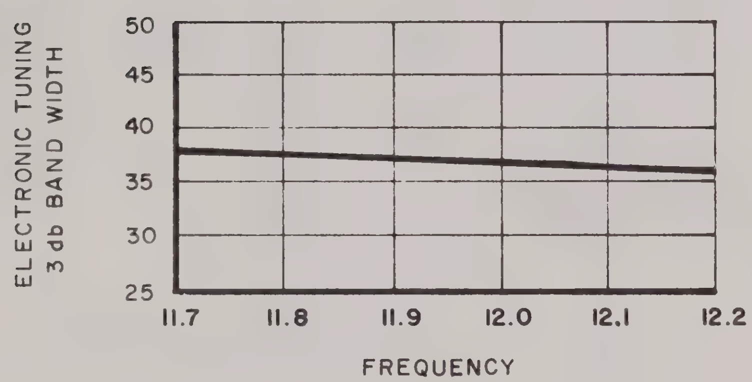
The heater and cathode of the X1116A are internally connected. When the resonator of this tube is operated at chassis potential. the heater transformer must be insulated for the cathode-to-resonator voltage.

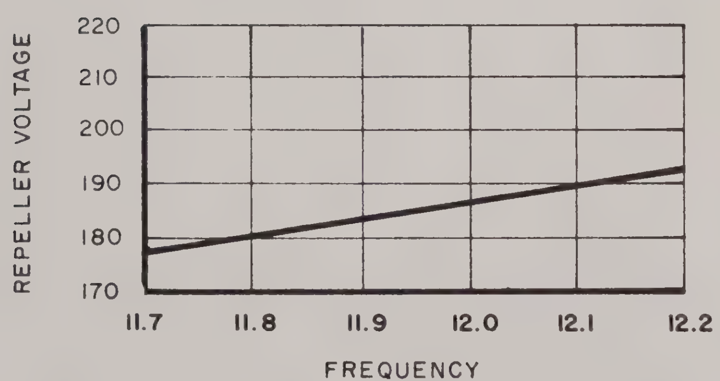
Mechanical Tuning: In the X1116A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

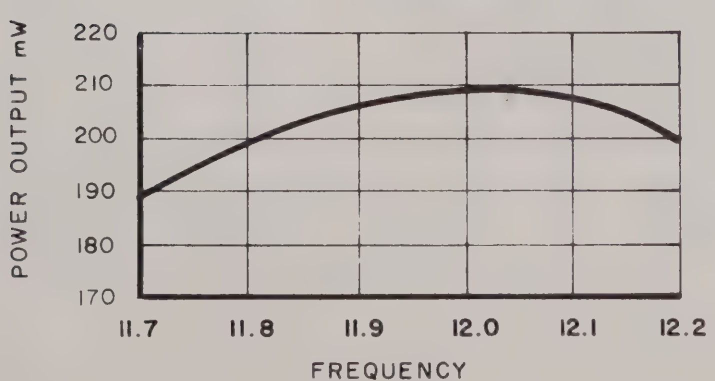
A clockwise rotation of the tuner will produce a decrease in frequency.

X1116A OPERATING CHARACTERISTICS

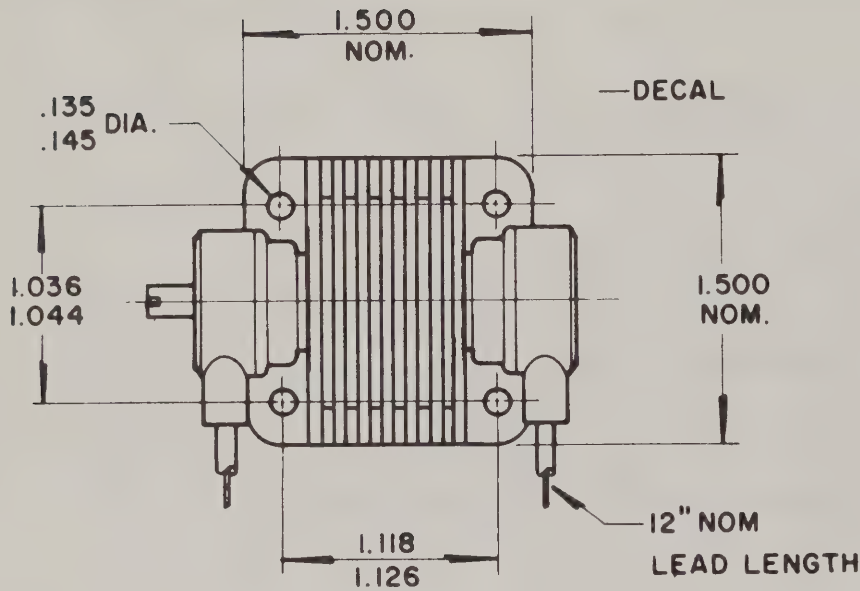
Ers = 400 V.
$5\frac{3}{4}$ MODE







X1116A



CONNECTIONS

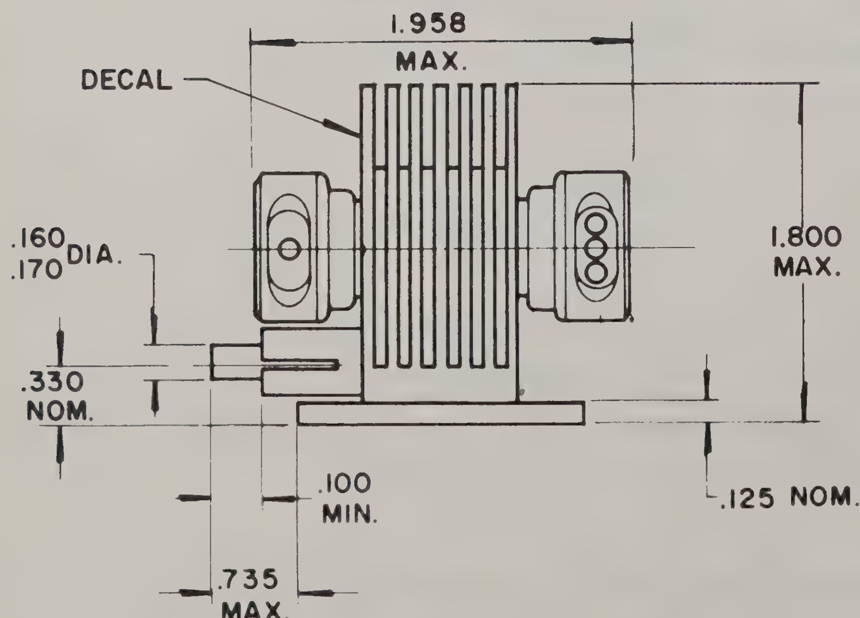
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED



EITEL-McCULLOUGH, INC.

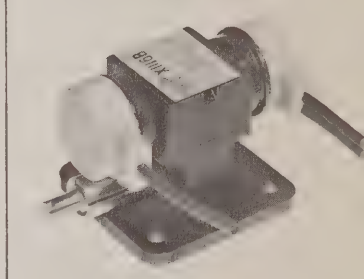
TENTATIVE DATA

X1116B

REFLEX KLYSTRON

The Eimac X1116B is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in 11.7 - 12.2 Gc. microwave relay equipments. The tube provides a minimum power output of 30 mW and is tunable across the entire 500 Mc. band.

The X1116B features low-noise gridless gun construction, good power and frequency stability and is conservatively warranteed for 1000 hours life.



GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		30	milliwatts
Frequency Range		11,700 to 12,200	megacycles

MECHANICAL

Operating Position	Any
Mounting	WR-75 Waveguide Flange
Cooling	Conduction
Electrical Connections	Flexible Leads
RF Output Coupling	WR-75 Waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.4 inches
Width	1.5 inches
Length	2.5 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-operating Shock (11 ms duration)	40 g
Maximum Operating Shock* (11 ms duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	425	MAX. VOLTS
DC CATHODE CURRENT	45	MAX. MA
RESONATOR DISSIPATION	20	MAX. WATTS
PEAK REPELLER VOLTAGE*		
NEGATIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
	400	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	400	volts
Mode		6-3/4
Frequency	11,950	megacycles
DC Cathode Current	26	milliamperes
DC Repeller Voltage*	-130	volts
DC Repeller Current	1	microampere
Power Output	40	milliwatts
Electronic Tuning (3 db bandwidth)	35	megacycles
Modulation Sensitivity ($E_r = \pm 3$ volts)	2.5	Mc/volt
Peak-to-peak FM Deviation (10 g, 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1116B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

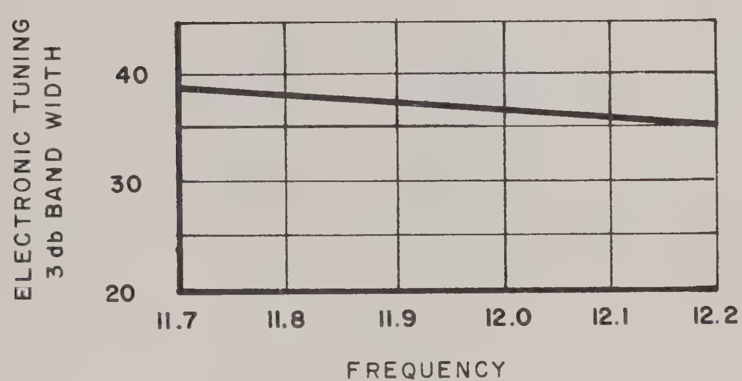
The heater and cathode of the X1116B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

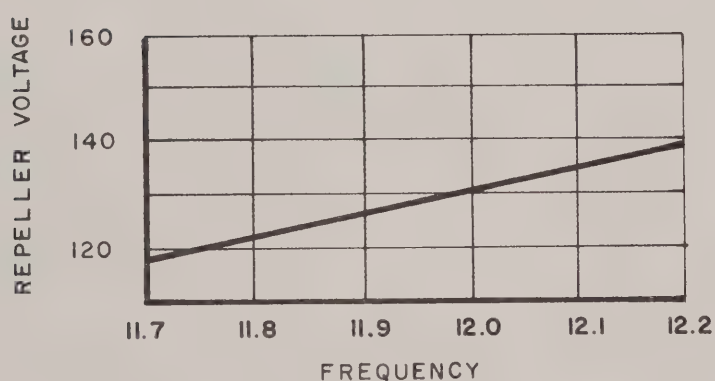
Mechanical Tuning: In the X1116B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

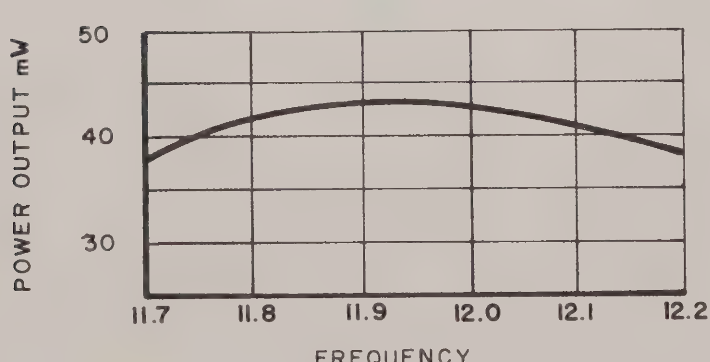
A clockwise rotation of the tuner will produce a decrease in frequency.

X1116 B OPERATING CHARACTERISTICS

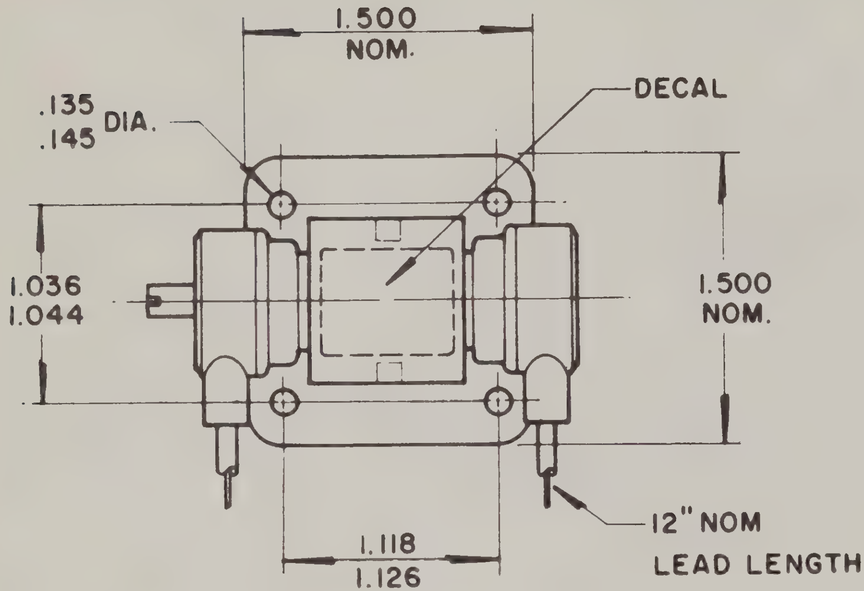
Ers = 300 V
$6\frac{3}{4}$ MODE







X1116B



CONNECTIONS

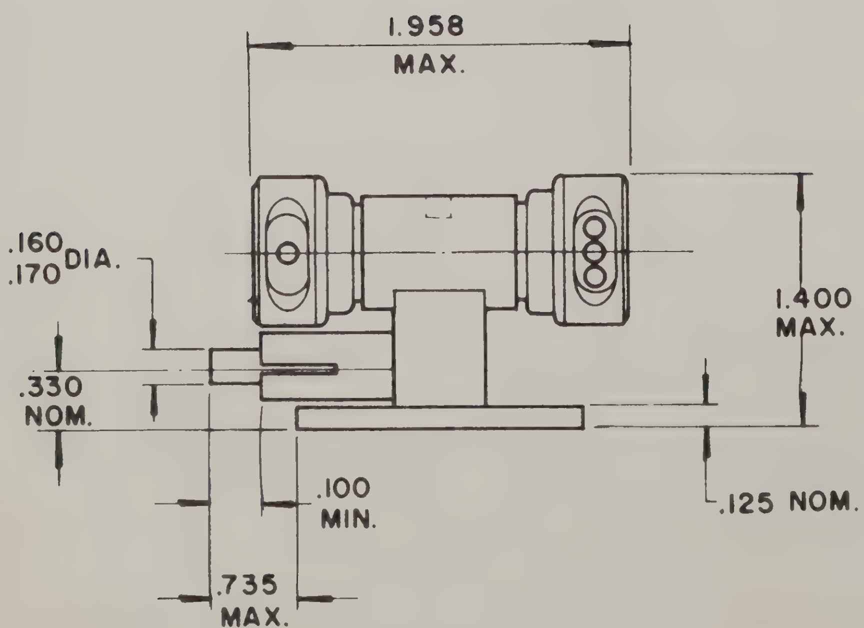
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED

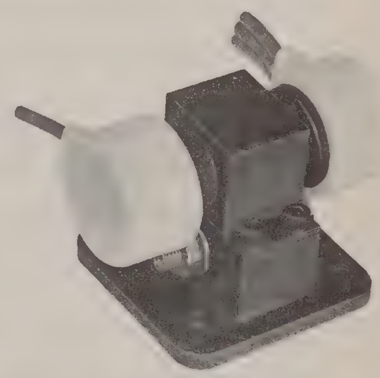


EITEL-McCULLOUGH, INC.

X-1120

REFLEX KLYSTRON
OPERATING-FREQUENCY
12.5 to 15 Gc
TRIMMABLE ± 50 Mc
MINIMUM OUTPUT POWER
200 mW

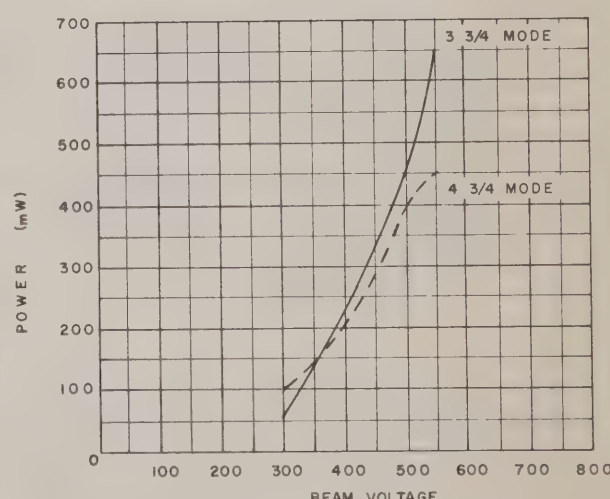
TYPICAL PERFORMANCE



KU-BAND

ELECTRICAL

Frequency Range	12.5 to 15 Gc (preset)
Resonator Voltage[2]	400 V
Output Power	225 mW
Cathode Current	38 mAdc
Repeller Voltage	−300 v
3db Bandwidth	35 Mc
Modulation Sensitivity	0.7 Mc/V
Temperature Coefficient	±100 Kc/°C
Heater Voltage (AC)[3]	6.3 v
Heater Current (AC)	1.25 A
VSWR	1.2:1 max
Mode	3-3/4

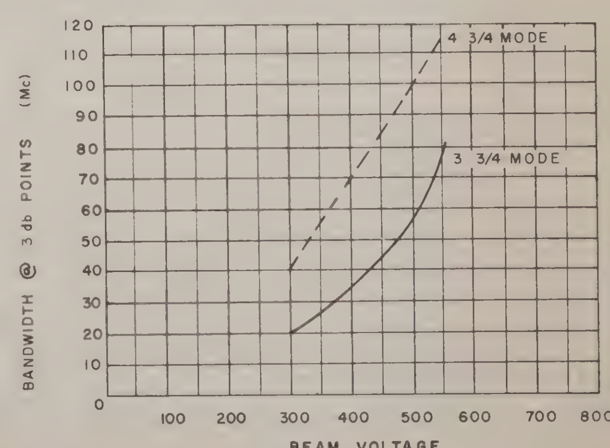


MECHANICAL

Operating Position	Any
Mounting	Waveguide Flange
RF Output Coupling	RG/91U Waveguide
Net Weight	6 ounces
Cooling[1]	(See note 1)

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	NO LIMIT
Maximum Shock (11ms duration)[4]	40g
Maximum Operating Vibration[4] (20-2000cps)	10g



OUTLINE DIMENSIONS

Height	1.400 inches
Width	1.312 inches
Length	2.100 inches

APPLICATION NOTES

1. COOLING: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150°C. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175°C. For maximum tube life, the operating temperature should be less than 100°C.

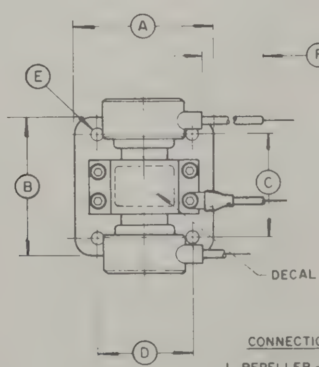
2. RESONATOR: The resonator of the X 1120 is integral with the body of the kylstron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

3. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and catholde of the X 1120 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

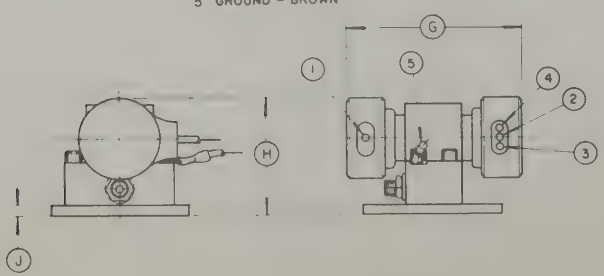
4. SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20 - 2000 cps) or shock of up to 40g (11 milliseconds duration).

   With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



Eimac

EITEL-McCULLOUGH, INC.

X-1120B

REFLEX KLYSTRON

OPERATING FREQUENCY
13.325 Gc

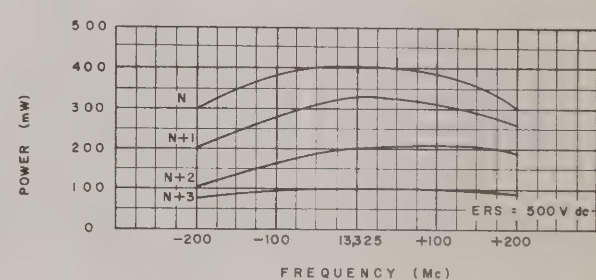
OUTPUT POWER
200 mW @ 150 Mc (etr)

TYPICAL PERFORMANCE

KU BAND

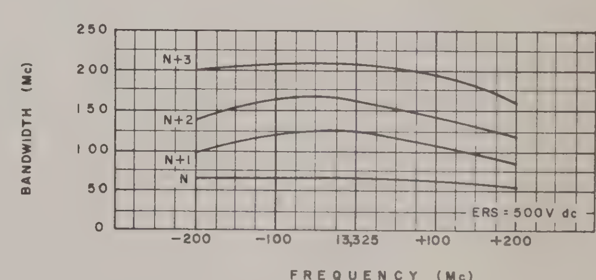
ELECTRICAL

Frequency Range	13.325 (Fixed)
Resonator Voltage[2]	500 V
Output Power	200 mW
Cathode Current	52 mAdc
Repeller Voltage	−150 Vdc
3db Bandwidth	155 Mc
Modulation Sensitivity	4.5 Mc/V
Temperature Coefficient	±150 Kc/°C
Heater Voltage (AC)[3]	6.3 V
Heater Current (AC)	1.25 A
VSWR	1.2:1 max
Mode	N+2
Service	Doppler Navigator Tube



MECHANICAL

Operating Position	Any
Mounting	Waveguide Flange
RF Output Coupling	RG/91U Waveguide
Net Weight	6 ounces
Cooling[1]	(See note 1)

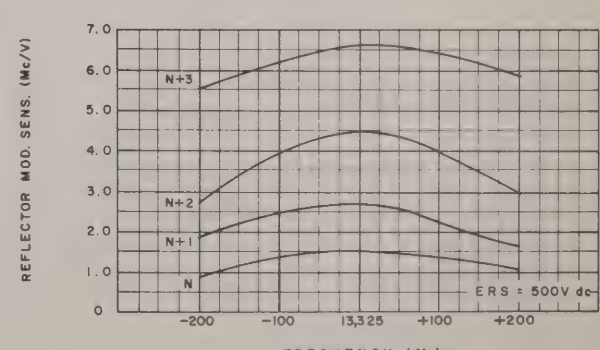


ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	NO LIMIT
Maximum Shock (11ms duration)[4]	40 g
Maximum Operating Vibration (20-2000cps)[4]	10 g

OUTLINE DIMENSIONS

Height	1.400 inches
Width	1.312 inches
Length	2.100 inches



APPLICATION NOTES

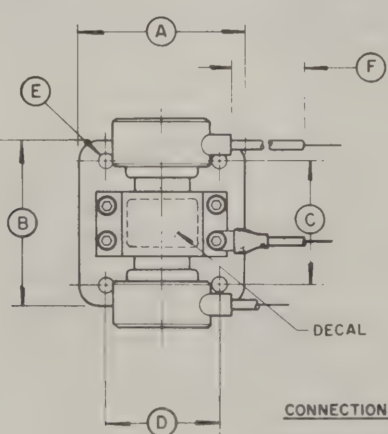
1. COOLING: The X 1120B may be cooled by conduction if the connecting waveguide flange provides an adequate heat sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade.

2. RESONATOR: The resonator of the X 1120B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

3. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and cathode of the X 1120B are internally connected. When the resonator of this tube is operated chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

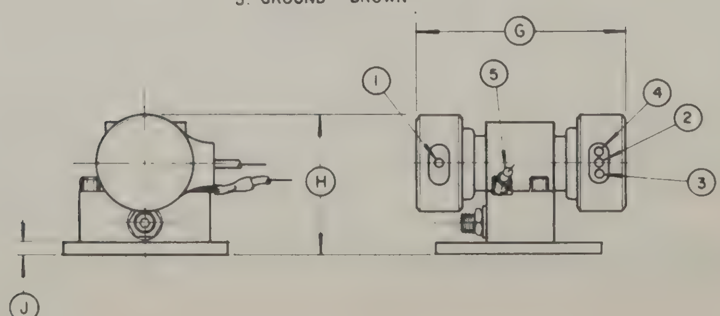
4. SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20 - 2000 cps) or shock of up to 40g (11 milliseconds duration). With a vibration level of 10g to any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER – GREY
2. HEATER – YELLOW
3. CATHODE – GREEN
4. HEATER CATHODE – WHITE
5. GROUND – BROWN



Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X-1130

REFLEX KLYSTRON

OPERATING FREQUENCY
15-18 Gc
TRIMMABLE ±50 Mc

MINIMUM OUTPUT POWER
200 mW

TYPICAL PERFORMANCE

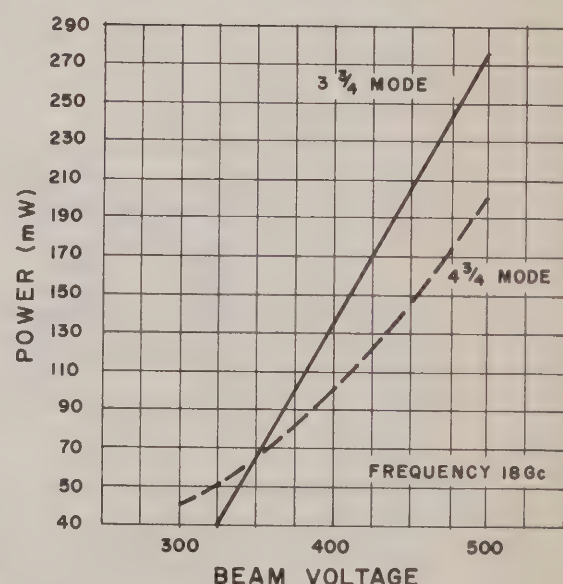
ELECTRICAL

Frequency Range 15.0 to 18 Gc (preset)	
Resonator Voltage[2]	500 V
Output Power	250 mW
Cathode Current	52 mAdc
Repeller Voltage	-300 V
3db Bandwidth	35 Mc
Modulation Sensitivity	0.7 Mc/V
Temperature Coefficient	±150 Kc/°C
Heater Voltage (AC)[3]	6.3 V
Heater Current(AC)	1.25 A
VSWR	1.2:1 max
Mode	3-3/4

KU-BAND

MECHANICAL

Operating Position	Any
Mounting	Waveguide Flange
RF Output Coupling	RG-91/U waveguide
Net Weight	6 ounces
Cooling[1]	(See note 1)

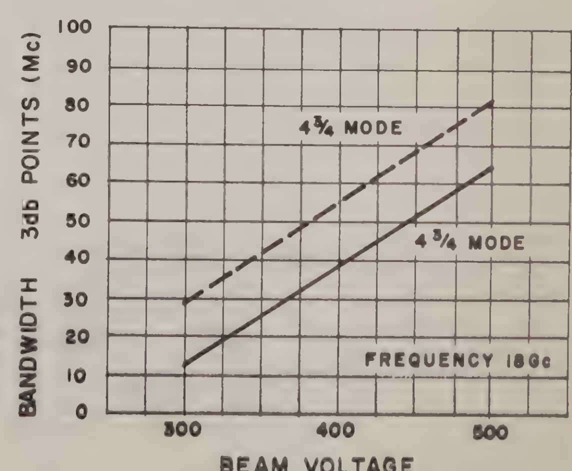


ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	NO LIMIT
Maximum Shock (Hms duration)[4]	40 g
Maximu Operating Vibration (20-2000cps)[4]	10 g

OUTLINE DIMENSION

Height	1.40 inches
Width	1.312 inches
Length	2.100 inches



APPLICATION NOTES

1. COOLING: The X 1130 may be cooled by conduction if the connecting waveguide flange provides an adequate heat sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade.

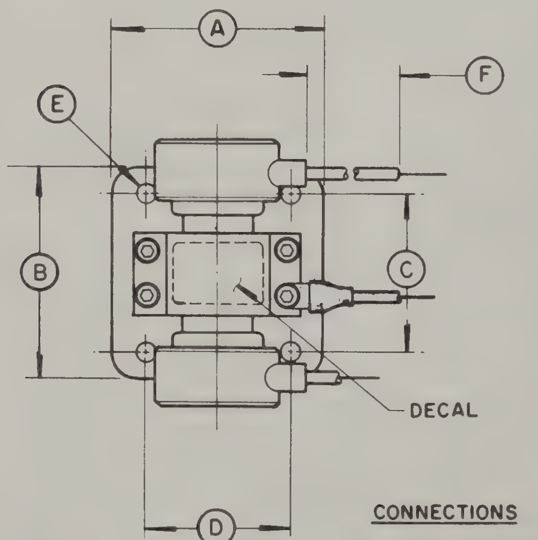
2. RESONATOR: The resonator of the X 1130 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

3. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and cathode of the X 1130 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

4. SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2000 cps) or shock of up to 40g (11 milliseconds duration).

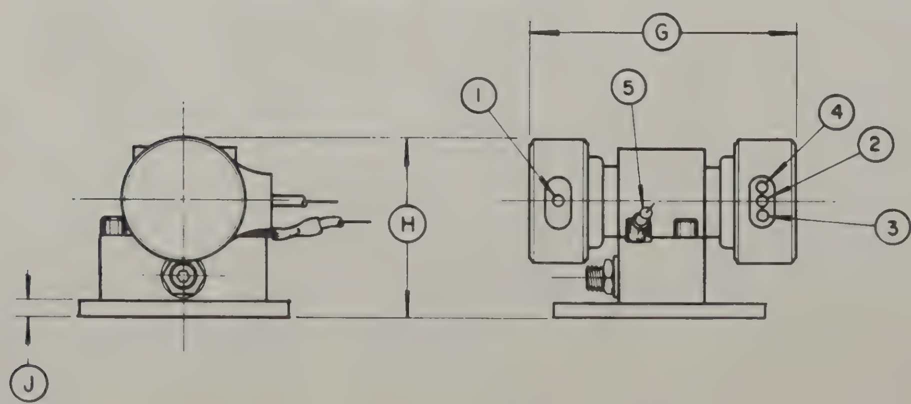
   With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

TENTATIVE DATA

8198

EM-778

TRAVELING WAVE TUBE
5.0 to 11.0 Gc.
1 Watt Min.
60 db Gain

TENTATIVE DATA FOR EIMAC EM-778 TRAVELING WAVE TUBE

The Eimac 8198/EM-778 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of one watt throughout the frequency range of 5.0 to 11.0 gigacycles with a nominal small signal gain of 60 decibels. The 8198/EM-778 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the 8198/EM-778 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	−50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	5.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*: NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	5.0 to 11.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	60 decibels
D-C Beam Voltage*	2900 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-778 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-778 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

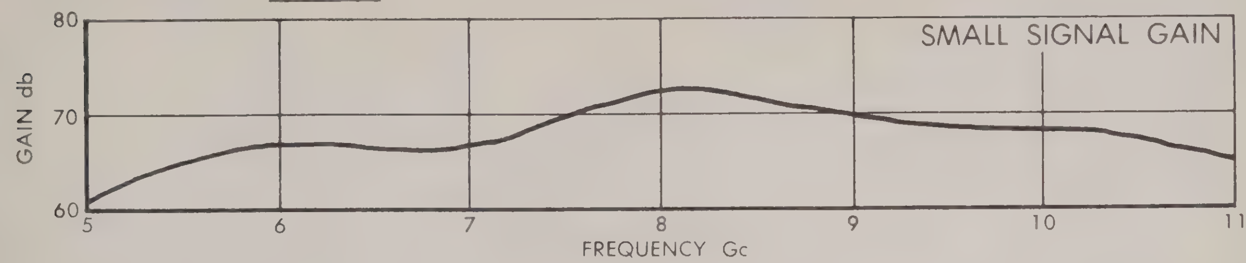
Temperature: –54°C to + 85°C

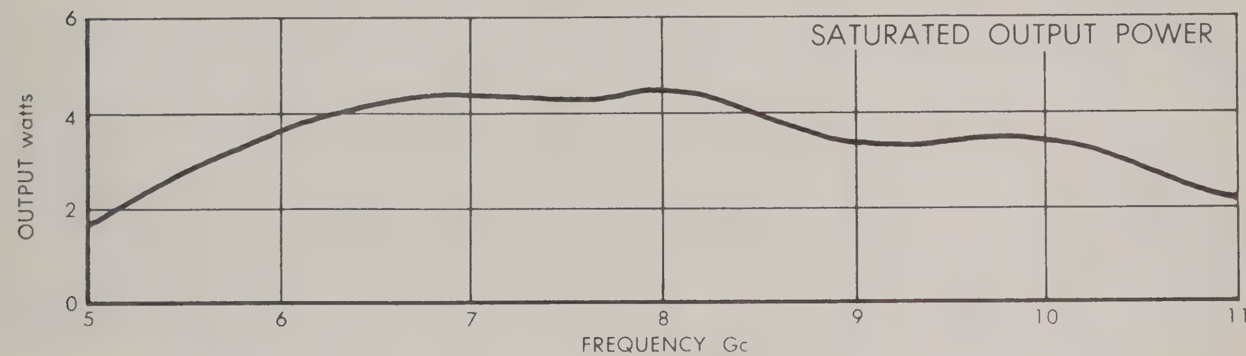
Altitude: 70,000 ft.

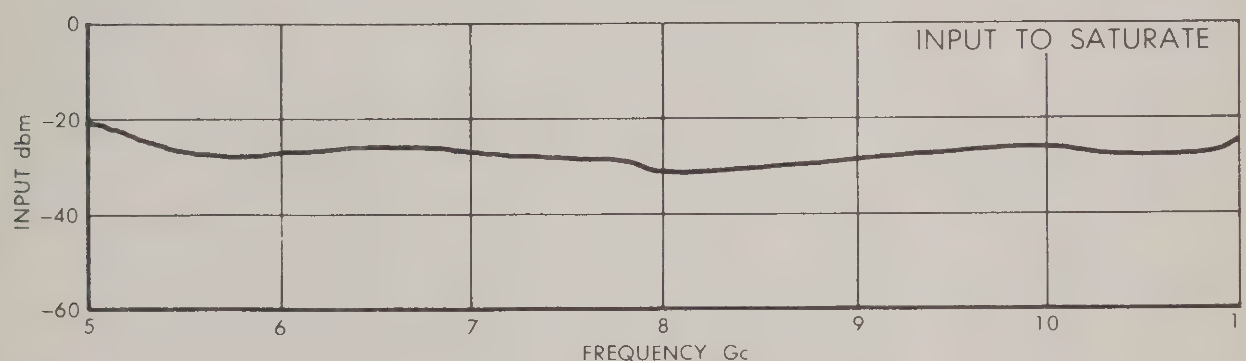
NOTE: This data should not be used for final equipment design.

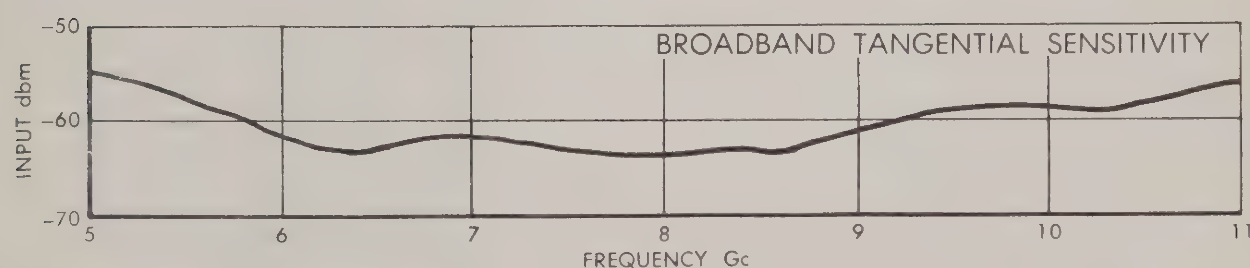
EM-778 TYPICAL OPERATING CHARACTERISTICS

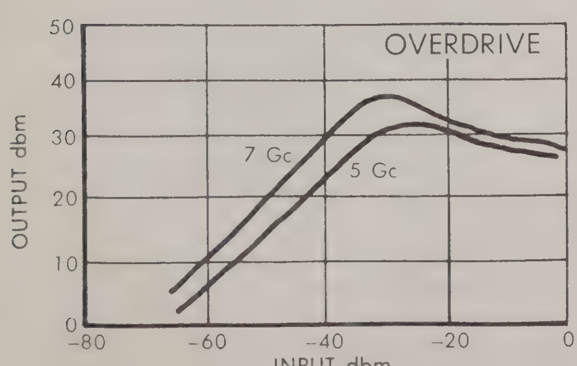
ANODE VOLTAGE	2900 Vdc	FOCUS VOLTAGE	–30 V dc
CATHODE CURRENT	23 mAdc	FILAMENT VOLTAGE	6.3 Vac

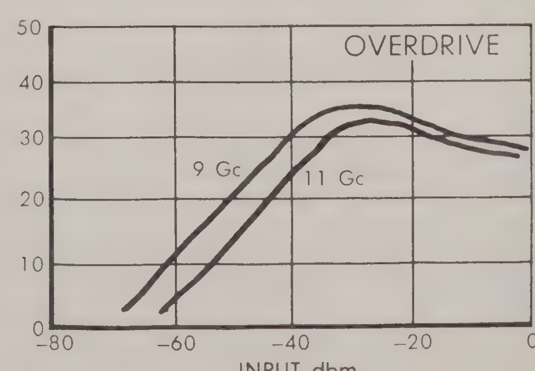








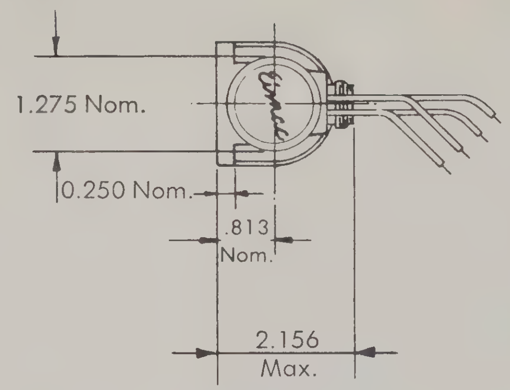


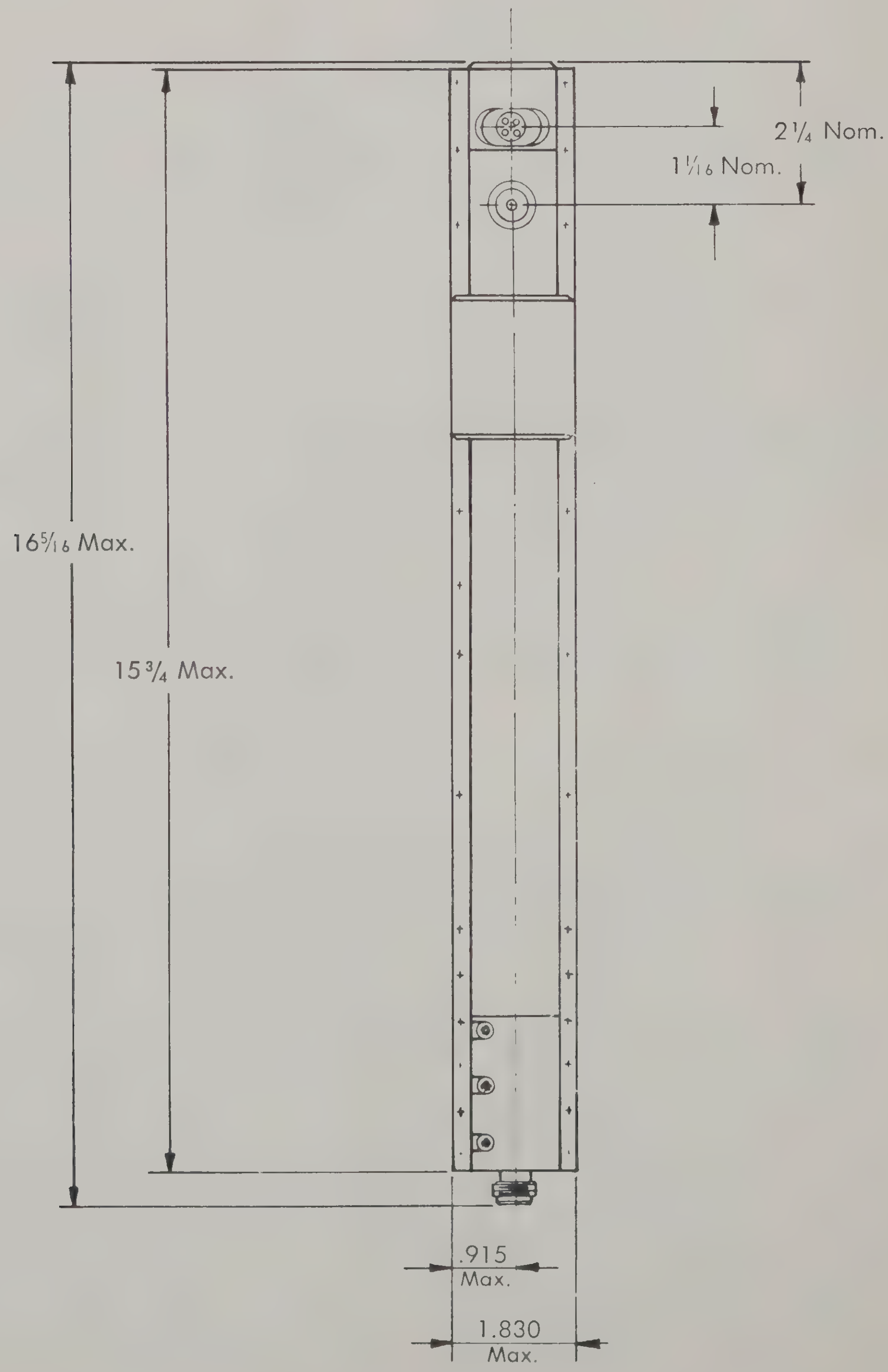


EM-778

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-779

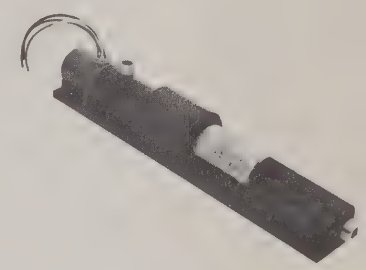
TRAVELING WAVE TUBE

5.0 to 11.0 Gc.

1 Watt Minimum

30 db Gain

TENTATIVE DATA FOR EIMAC EM-779 TRAVELING WAVE TUBE



The Eimac EM-779 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of one watt throughout the frequency range of 5.0 to 11.0 Gigacycles with a nominal small signal gain of 30 decibels. The EM-779 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the EM-779 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Saturated Output Power	1 watt
Frequency Range	5.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*: NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	5.0 to 11.0 gigacycles
Minimum Output Power	1.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	2950 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-779 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-779 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

Temperature: –54°C to + 85°C

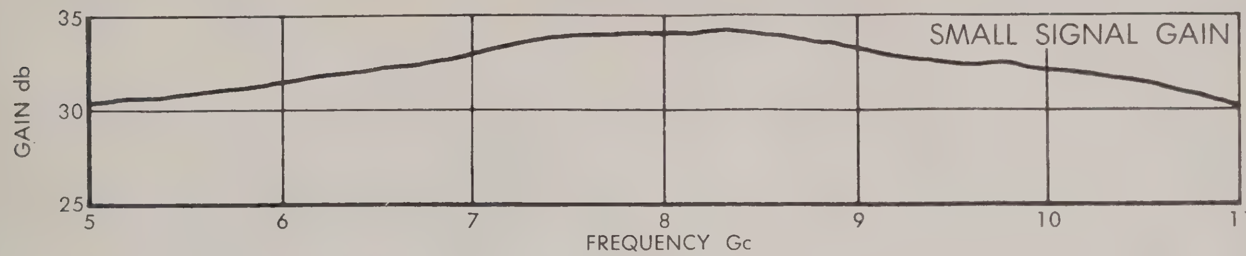
Altitude: 70,000 ft.

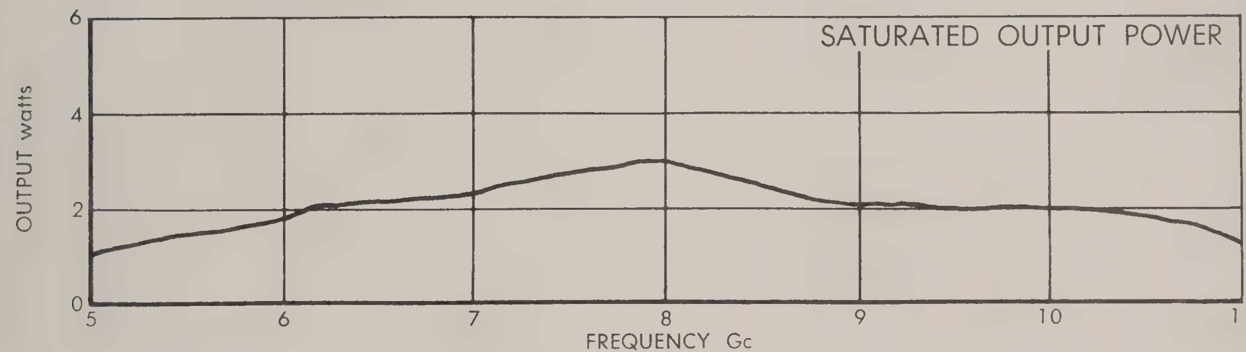
NOTE: This data should not be used for final equipment design.

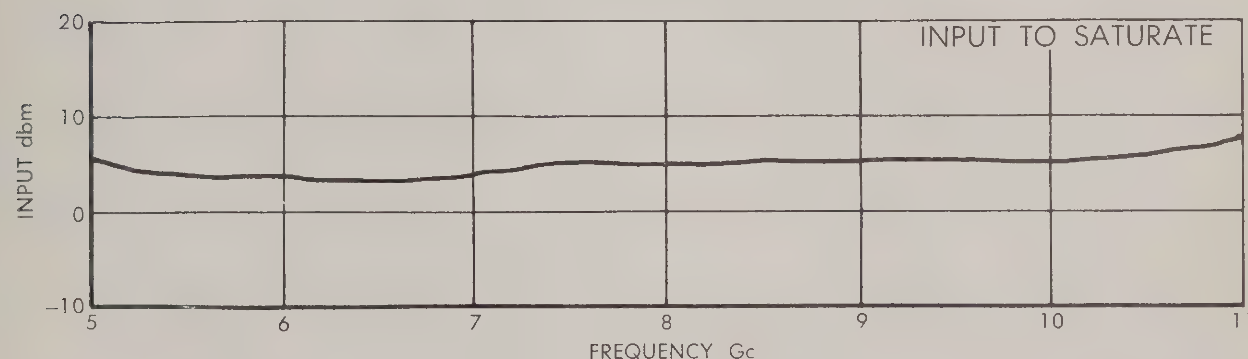
EM-779 TYPICAL OPERATING CHARACTERISTICS

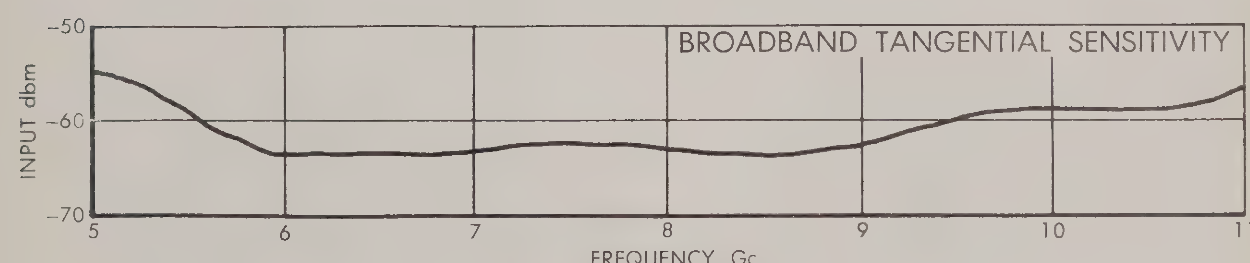
ANODE VOLTAGE 2950 Vdc FOCUS VOLTAGE −30 Vdc

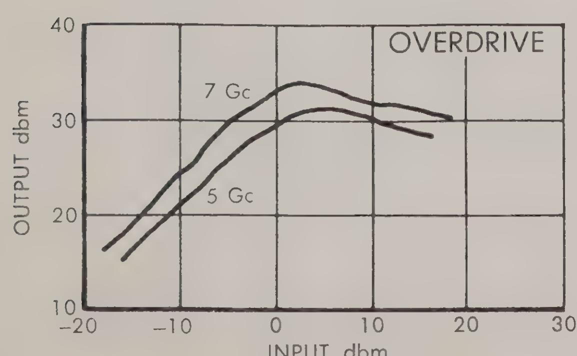
CATHODE CURRENT 23 mAdc FILAMENT VOLTAGE 6.3 Vac

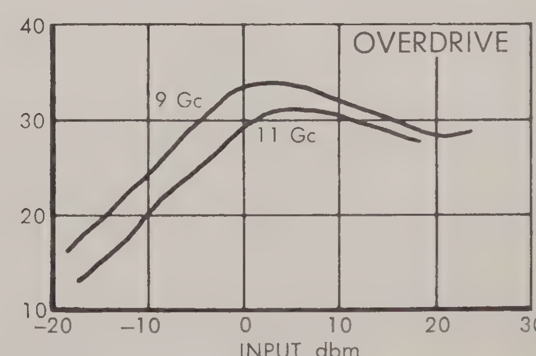








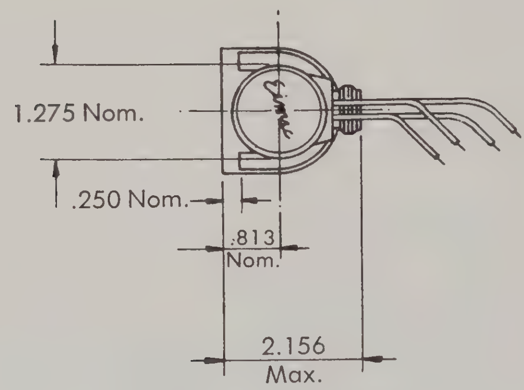


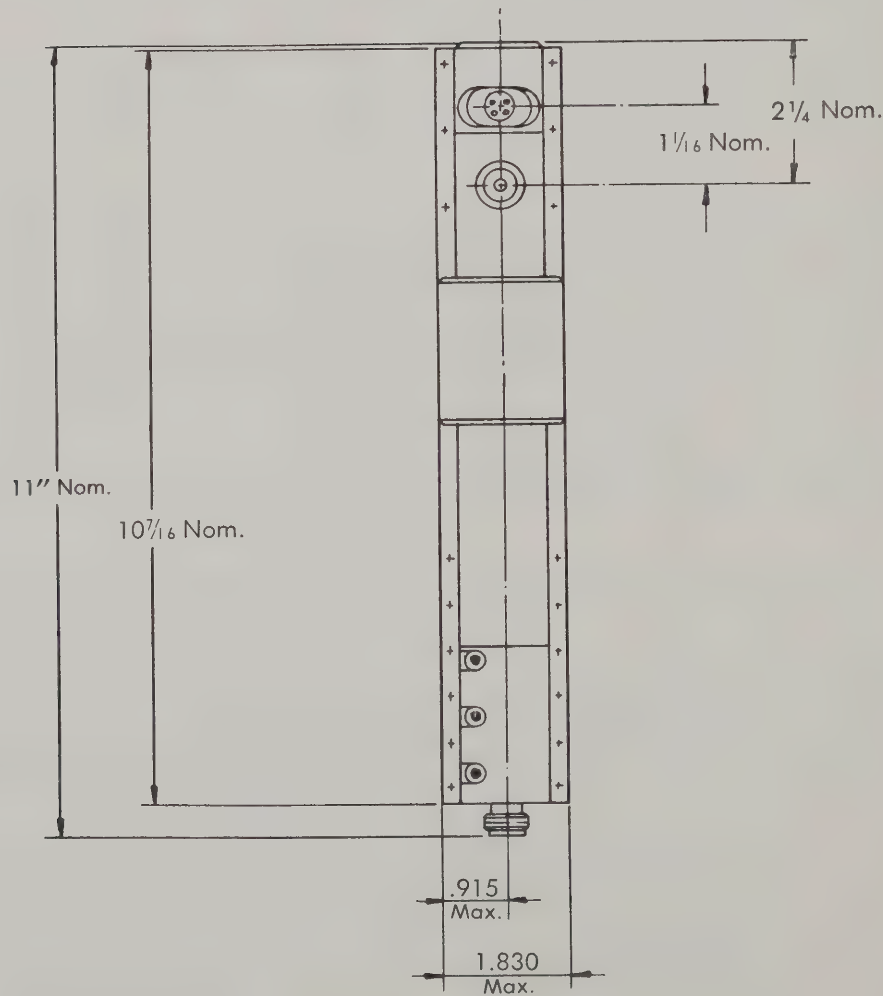


EM-779

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK

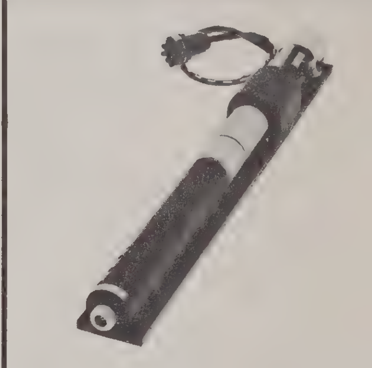




Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA
EM-1006
TRAVELING WAVE TUBE
2.0 to 4.0 Gc.
1 Watt Min.
55 db Gain



TENTATIVE DATA FOR EIMAC EM-1006 TRAVELING WAVE TUBE

The Eimac EM-1006 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM-1006 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 1 watt CW over the frequency range of 2.0 to 4.0 Gc with a minimum small signal gain of 55 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of + 85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	2.0 to 4.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	1300 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*: NEGATIVE WITH RESPECT TO CATHODE	—50 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	2.0 to 4.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	60 decibels
D-C Beam Voltage*	1150 volts
D-C Cathode Current	30 milliamperes
D-C Focus Electrode Voltage*	−30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1006 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1006 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

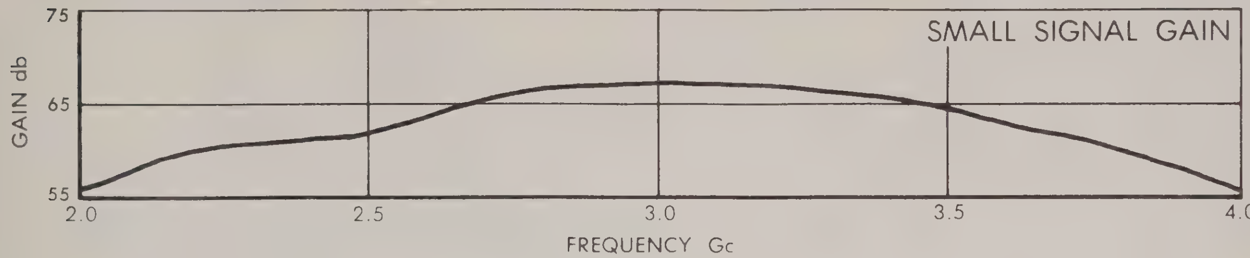
Temperature: −54°C to + 85°C

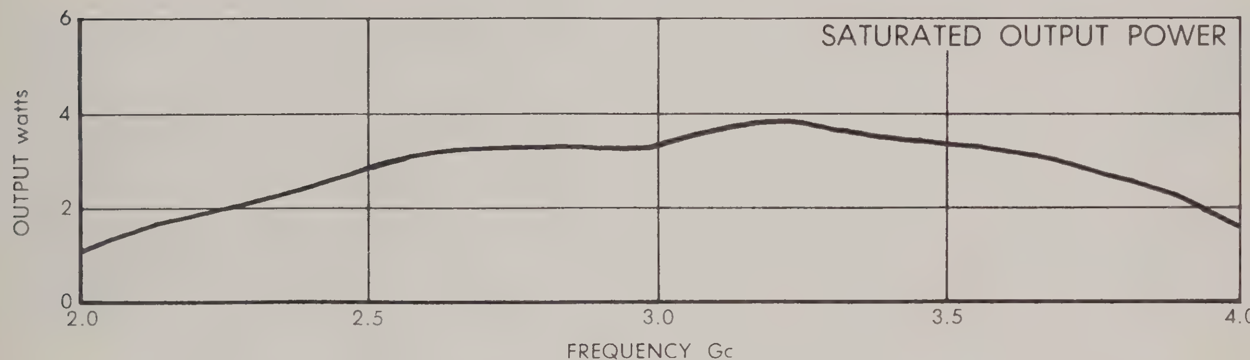
Altitude: 70,000 ft.

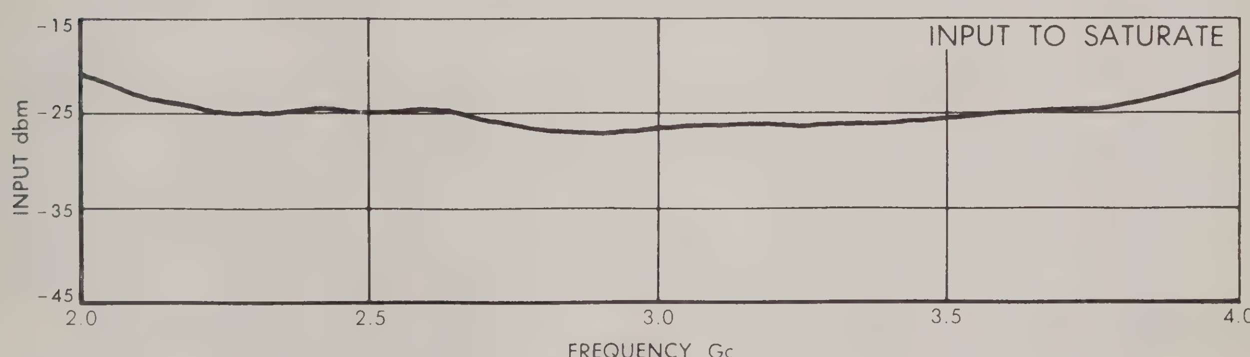
NOTE: This data should not be used for final equipment design.

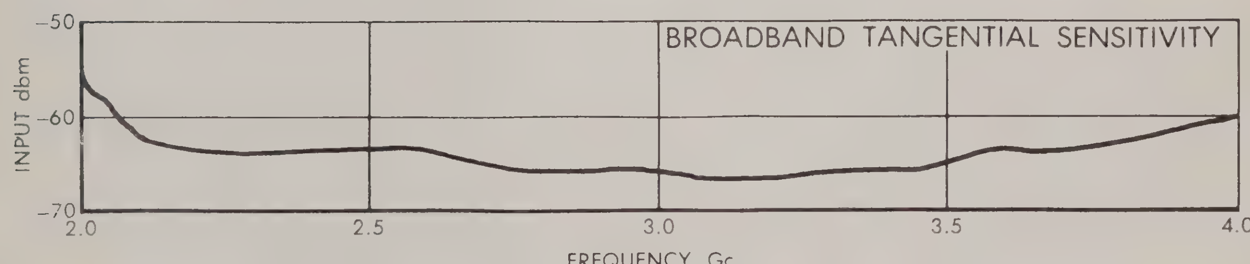
EM-1006 TYPICAL OPERATING CHARACTERISTICS

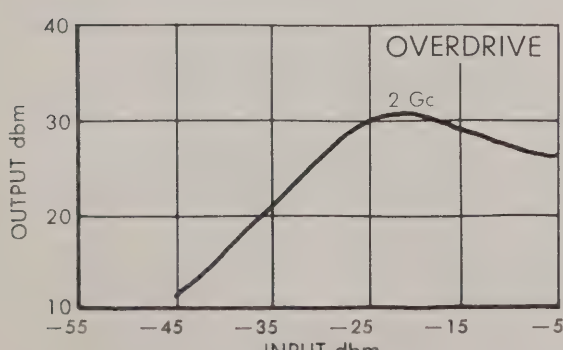
ANODE VOLTAGE	1150 Vdc	FOCUS VOLTAGE	–30 Vdc
CATHODE CURRENT	30 mAdc	FILAMENT VOLTAGE	6.3 V

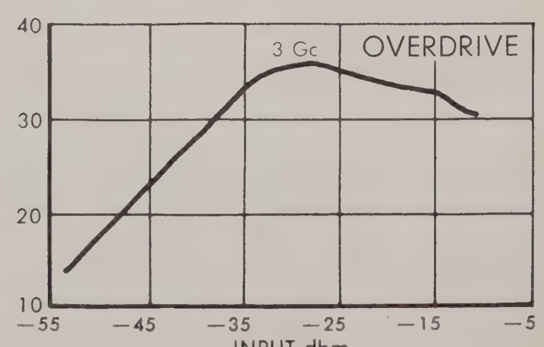








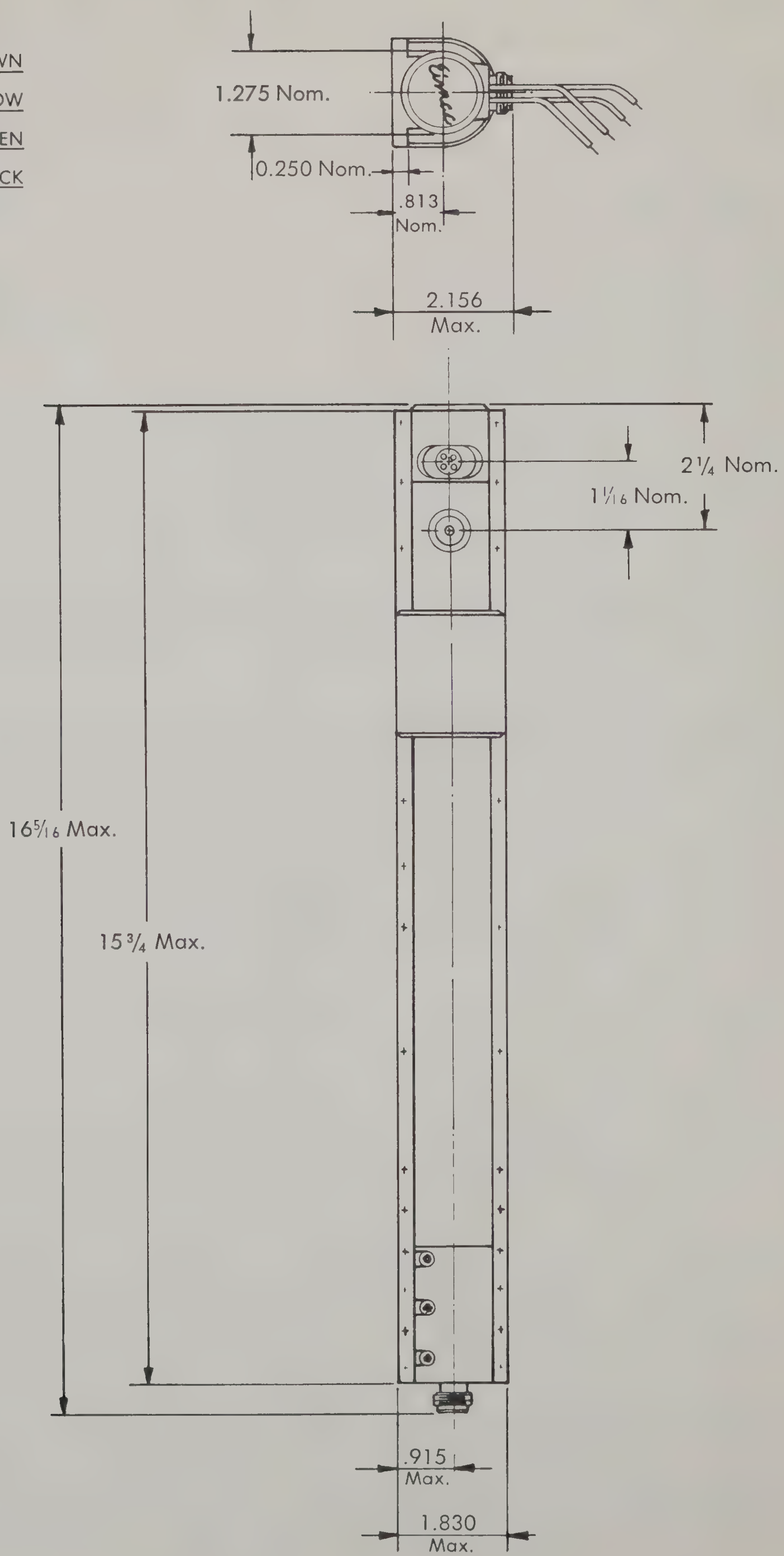




EM-1006

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



TENTATIVE DATA
EM-1010
TRAVELING WAVE TUBE
4.0 to 8.0 Gc.
1 Watt Min.
60 db Gain

EITEL-McCULLOUGH, INC.

TENTATIVE DATA FOR EIMAC EM-1010 TRAVELING WAVE TUBE

The Eimac EM-1010 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM-1010 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 1 watt CW over the frequency range of 4.0 to 8.0 Gc with a nominal small signal gain of 60 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of + 85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Saturated Output Power	1 watt
Frequency Range	4.0 to 8.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	2600 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*: NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	30 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	60 decibels
D-C Beam Voltage*	2550 volts
D-C Cathode Current	28 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1010 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1010 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

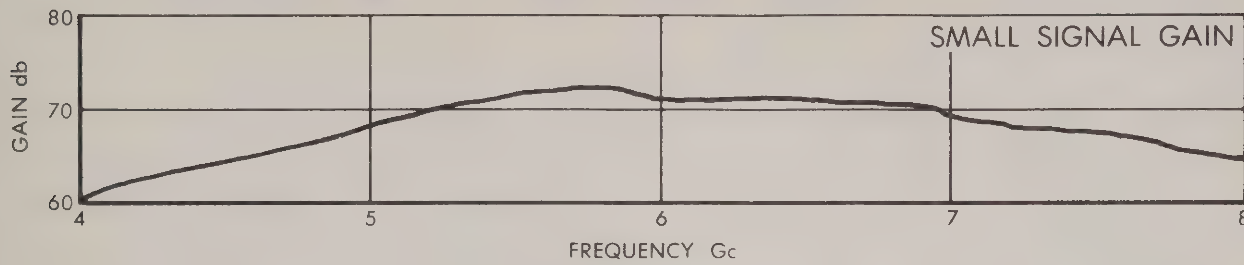
Temperature: –54°C to + 85°C

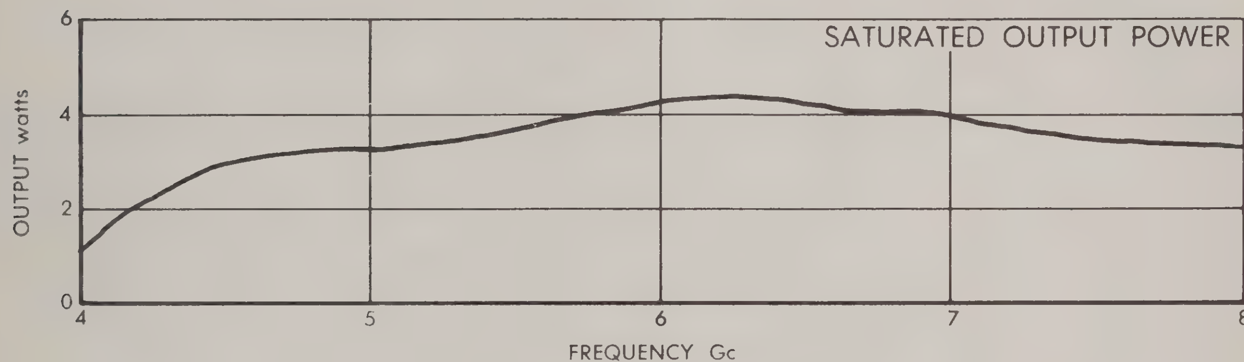
Altitude: 70,000 ft.

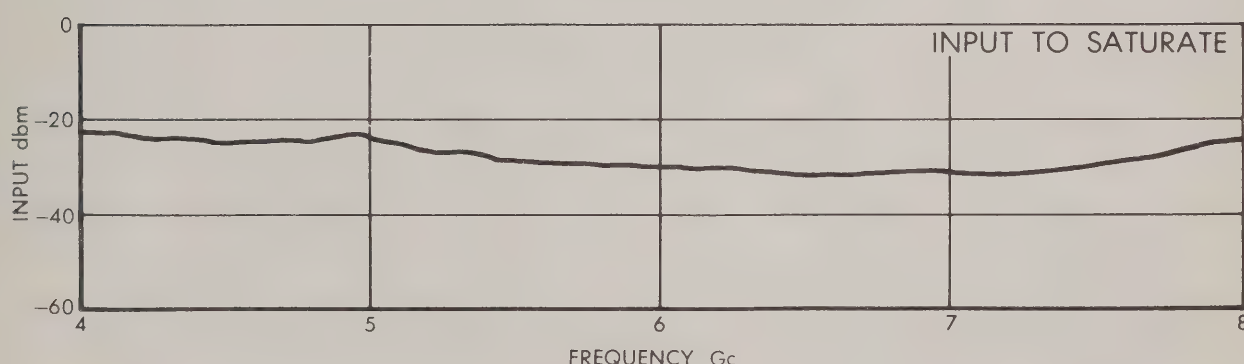
NOTE: This data should not be used for final equipment design.

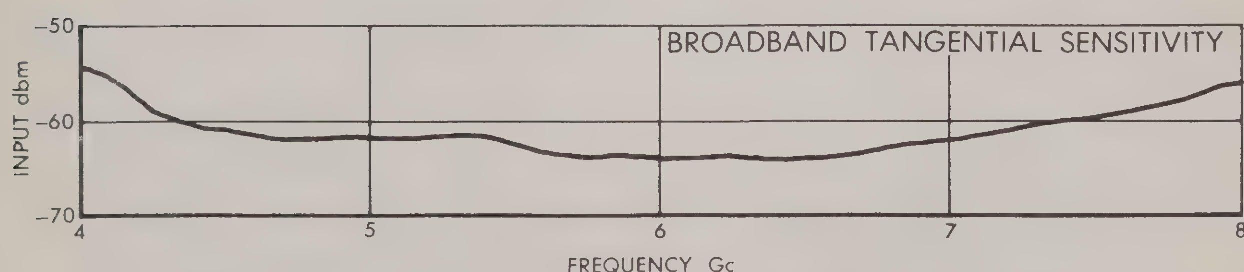
EM-1010 TYPICAL OPERATING CHARACTERISTICS

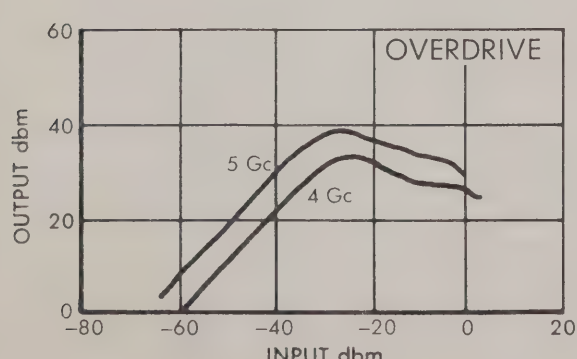
ANODE VOLTAGE	2550 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURRENT	28 mAdc	FILAMENT VOLTAGE	6.3 V

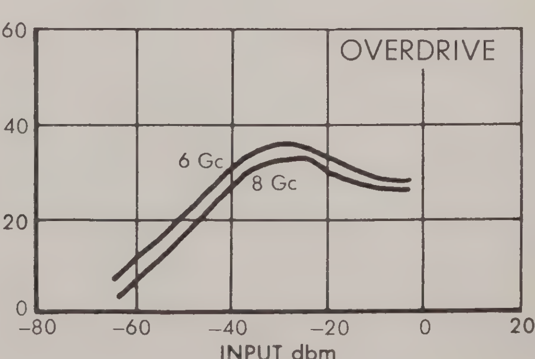








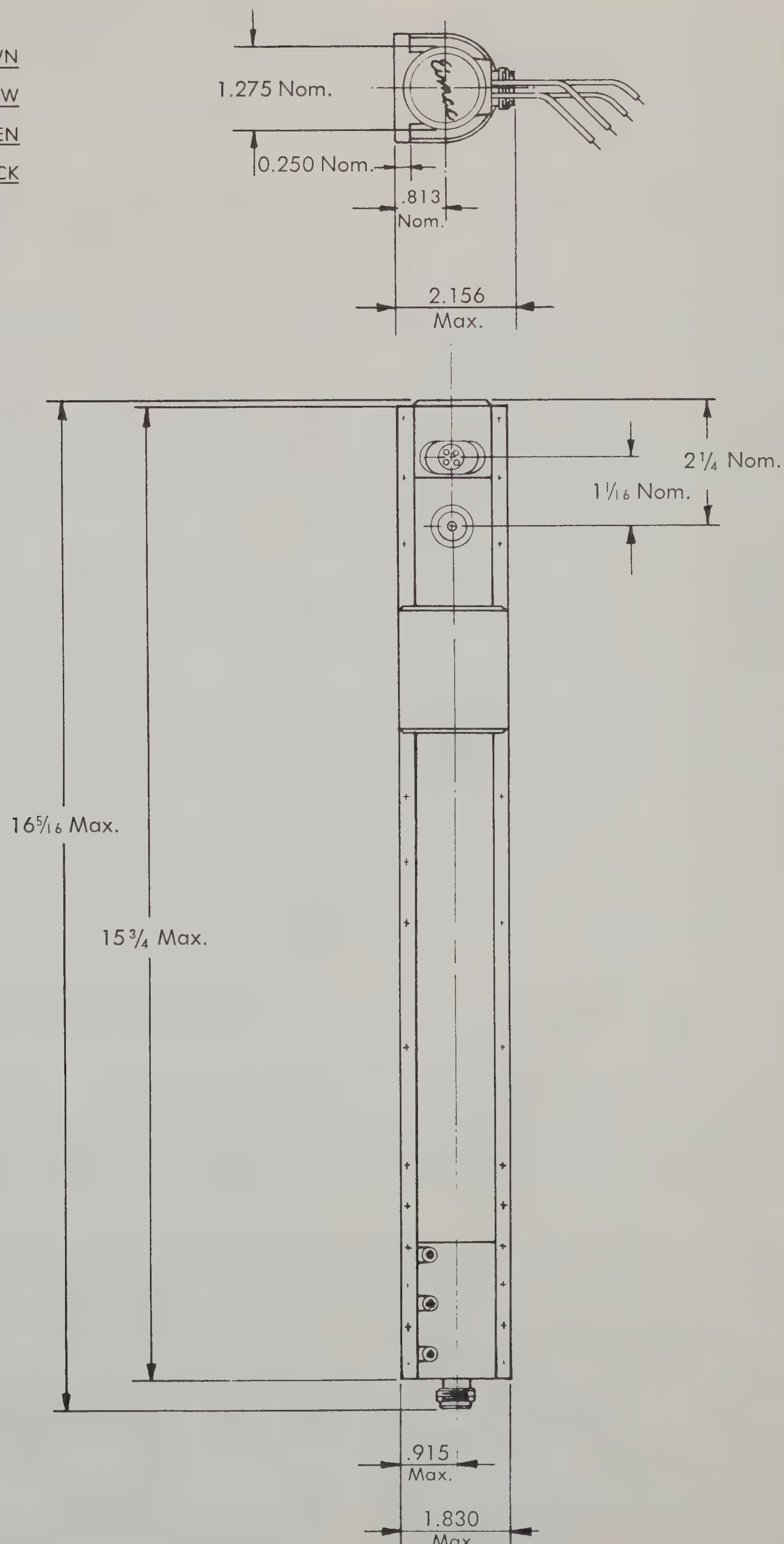




EM-1010

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA
EM-1011
TRAVELING WAVE TUBE
4.0 to 8.0 Gc.
1 Watt Min.
30 db Gain

TENTATIVE DATA FOR EIMAC EM-1011 TRAVELING WAVE TUBE

The Eimac EM-1011 is an intermediate-power traveling wave tube amplifier designed to operate in the 4.0 to 8.0 Gc frequency range. The EM-1011 will provide a minimum saturated power output of 1 watt over this frequency range with a nominal small signal gain of 30 db.

The EM-1011 features rugged ceramic and metal construction and focusing is provided by built-in periodic permanent magnets. These magnets are fully temperature compensated to allow operation from –55°C to + 85°C. No additional cooling is required at these temperatures due to the integral heat sink/mounting flange supplied with the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Saturated Output Power	1 watt
Frequency Range	4.0 to 8.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	2600 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*: NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	30 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	30 decibels
D-C Beam Voltage*	2550 volts
D-C Cathode Current	28 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1011 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1011 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

Temperature: –54°C to + 85°C

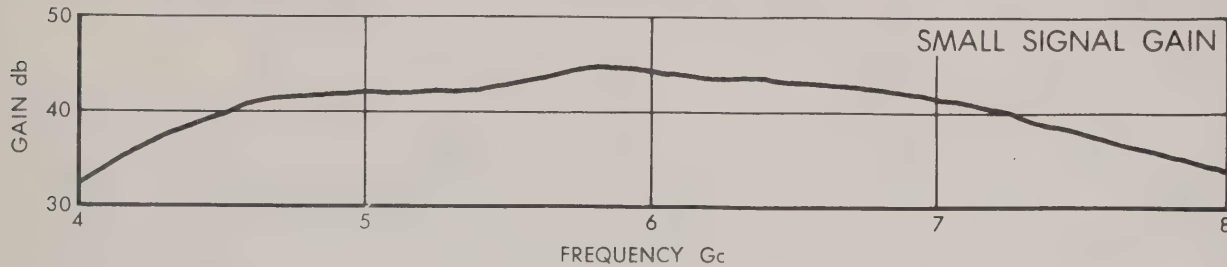
Altitude: 70,000 ft.

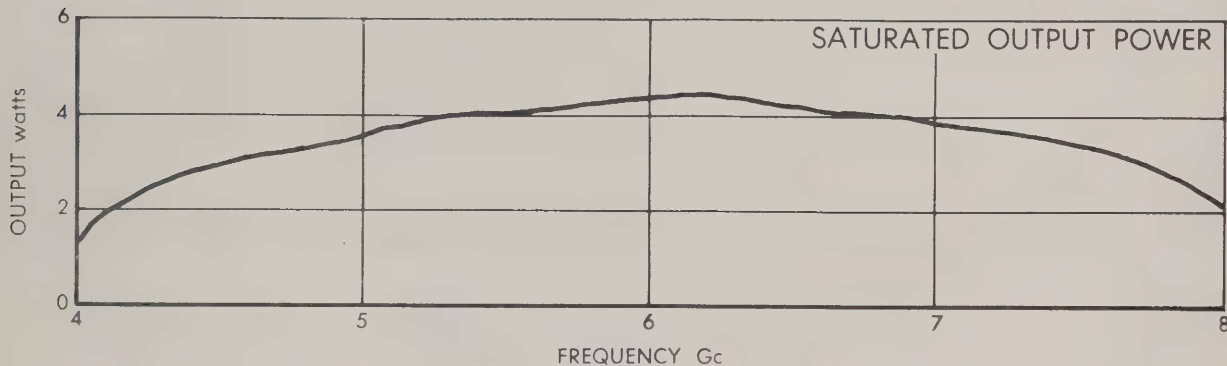
NOTE: This data should not be used for final equipment design.

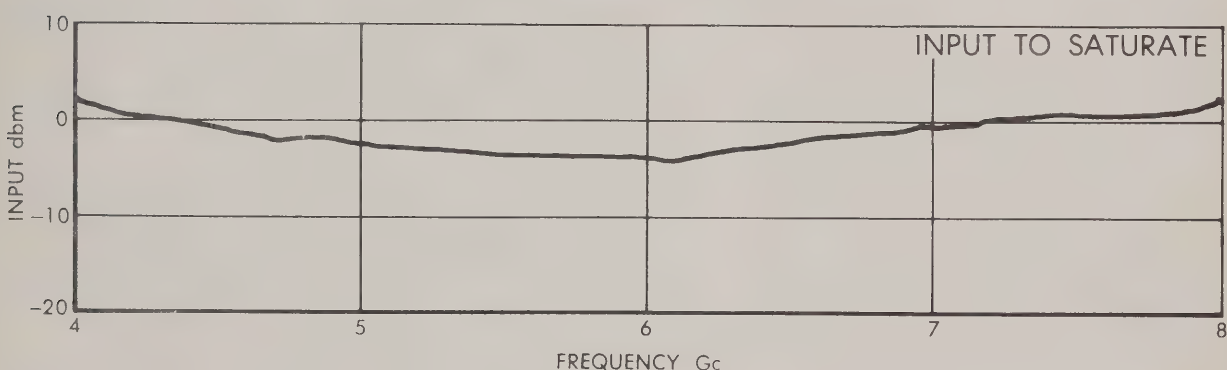
EM-1011 TYPICAL OPERATING CHARACTERISTICS

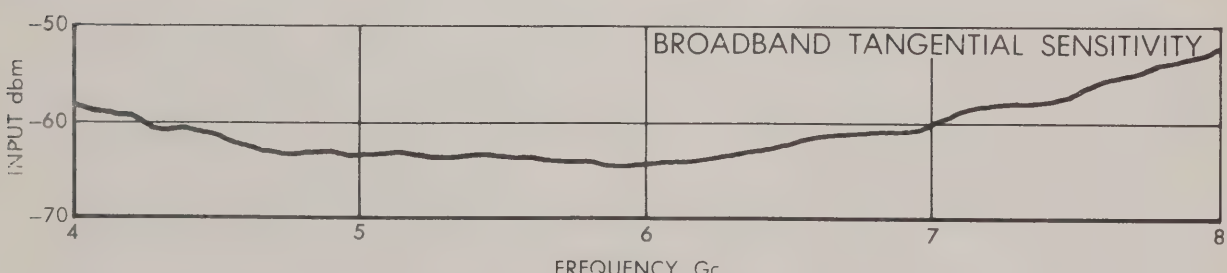
ANODE VOLTAGE 2550 Vdc — FOCUS VOLTAGE −30 Vdc

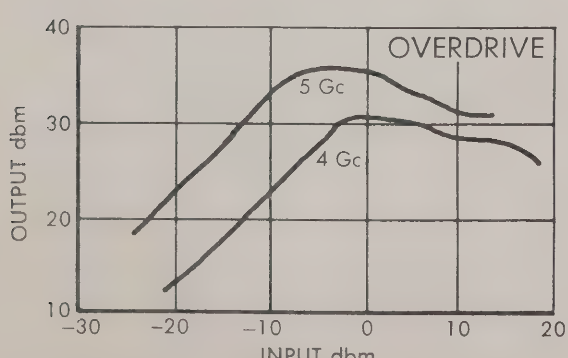
CATHODE CURRENT 28 mAdc — FILAMENT VOLTAGE 6.3 Vac

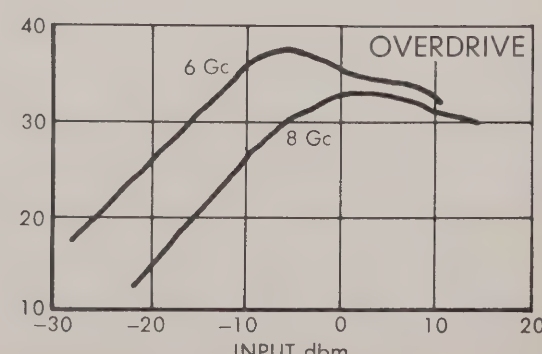








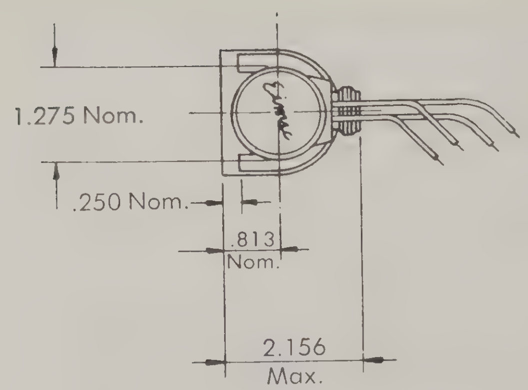


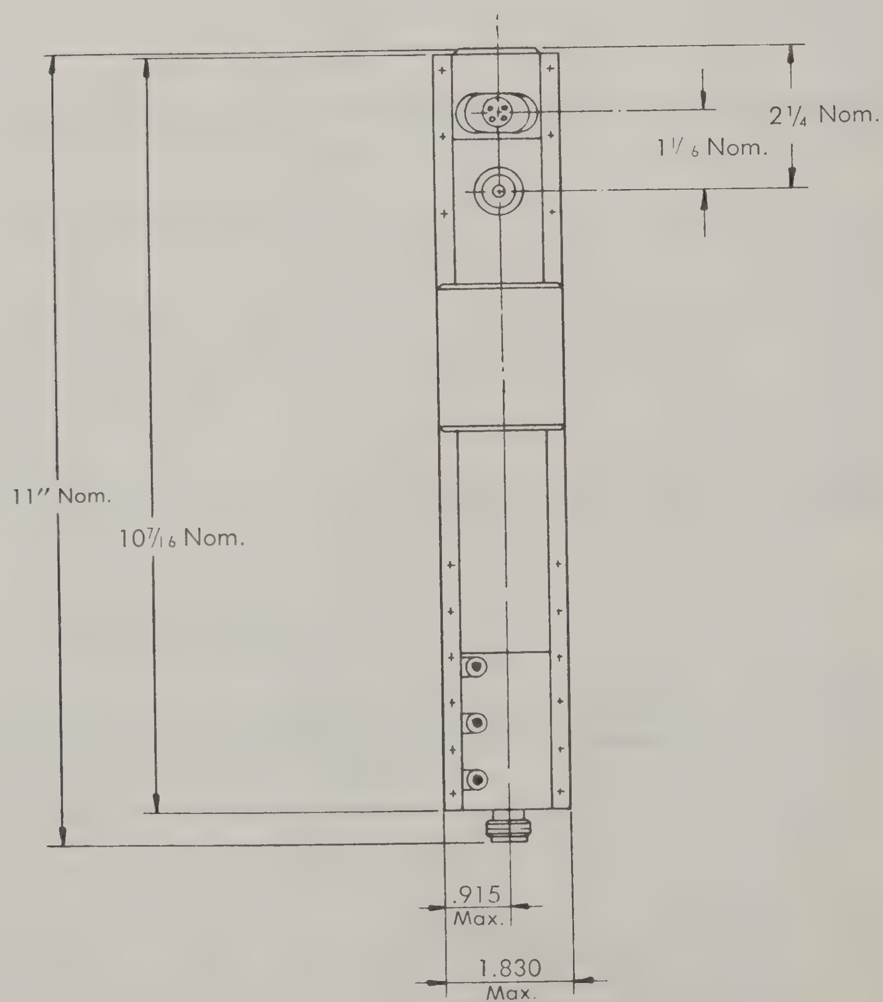


EM-1011

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-1015

TRAVELING WAVE TUBE

4.0 to 8.0 Gc.

3 Watts Min.

60 db Gain

TENTATIVE DATA FOR EIMAC EM-1015 TRAVELING WAVE TUBE

The Eimac EM-1015 is a very rugged, light weight power amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperatures. The EM-1015 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 3 watts CW over the frequency range of 4.0 to 8.0 Gc with a nominal small signal gain of 60 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of + 85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	4.0 to 8.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	2600 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:* NEGATIVE WITH RESPECT TO CATHODE	50 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	3.0 watts
Small Signal Gain	60 decibels
D-C Beam Voltage*	2550 volts
D-C Cathode Current	35 milliamperes
D-C Focus Electrode Voltage*	−40 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1015 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1015 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

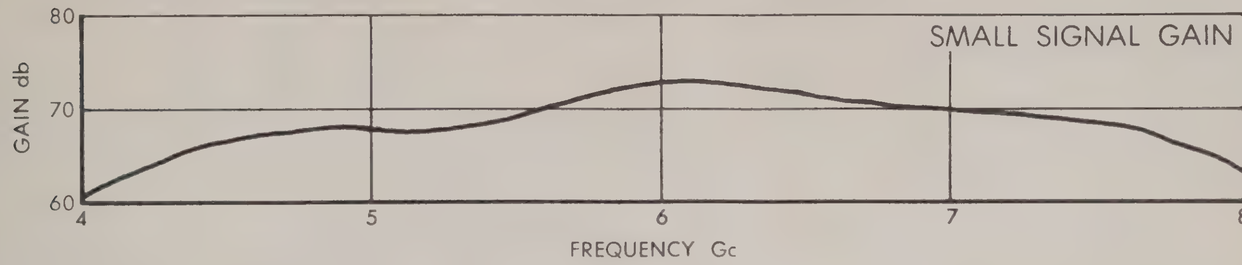
Temperature: −54°C to + 85°C

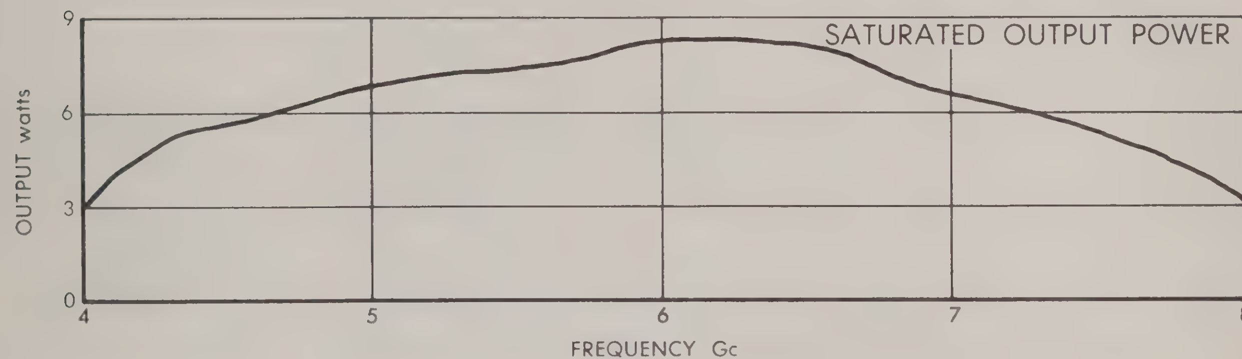
Altitude: 70,000 ft.

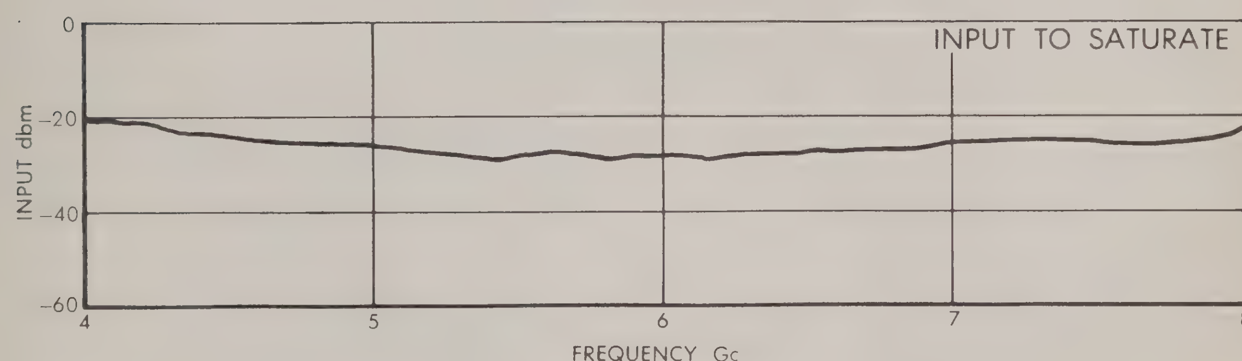
NOTE: This data should not be used for final equipment design.

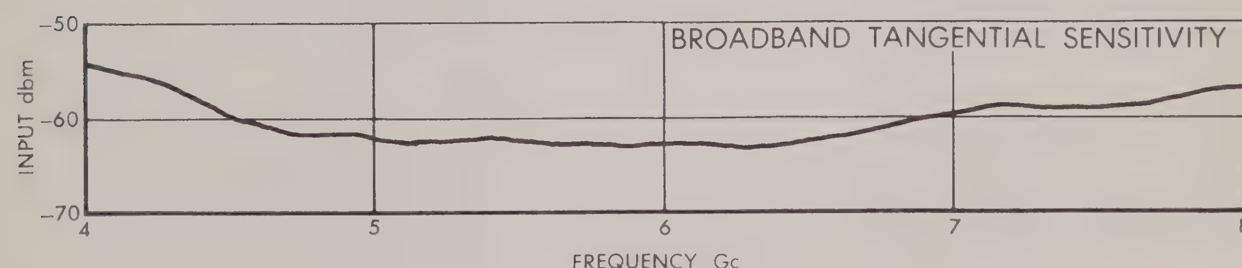
EM-1015 TYPICAL OPERATING CHARACTERISTICS

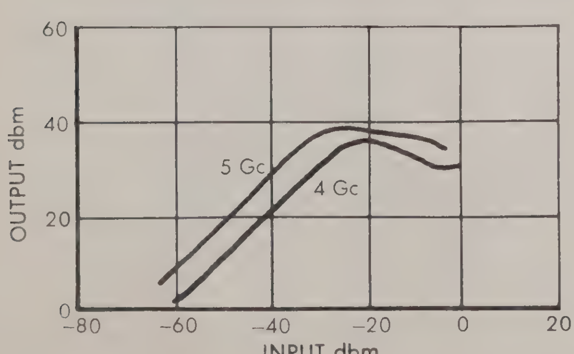
ANODE VOLTAGE 2550 Vdc
CATHODE CURRENT 35 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 V

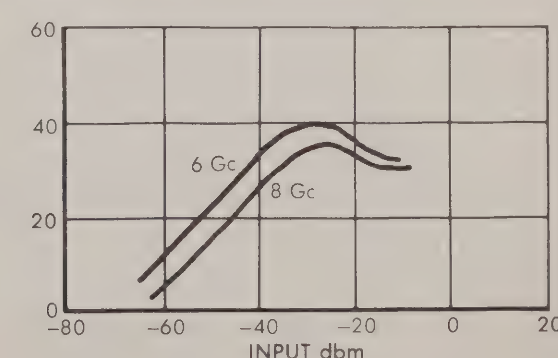








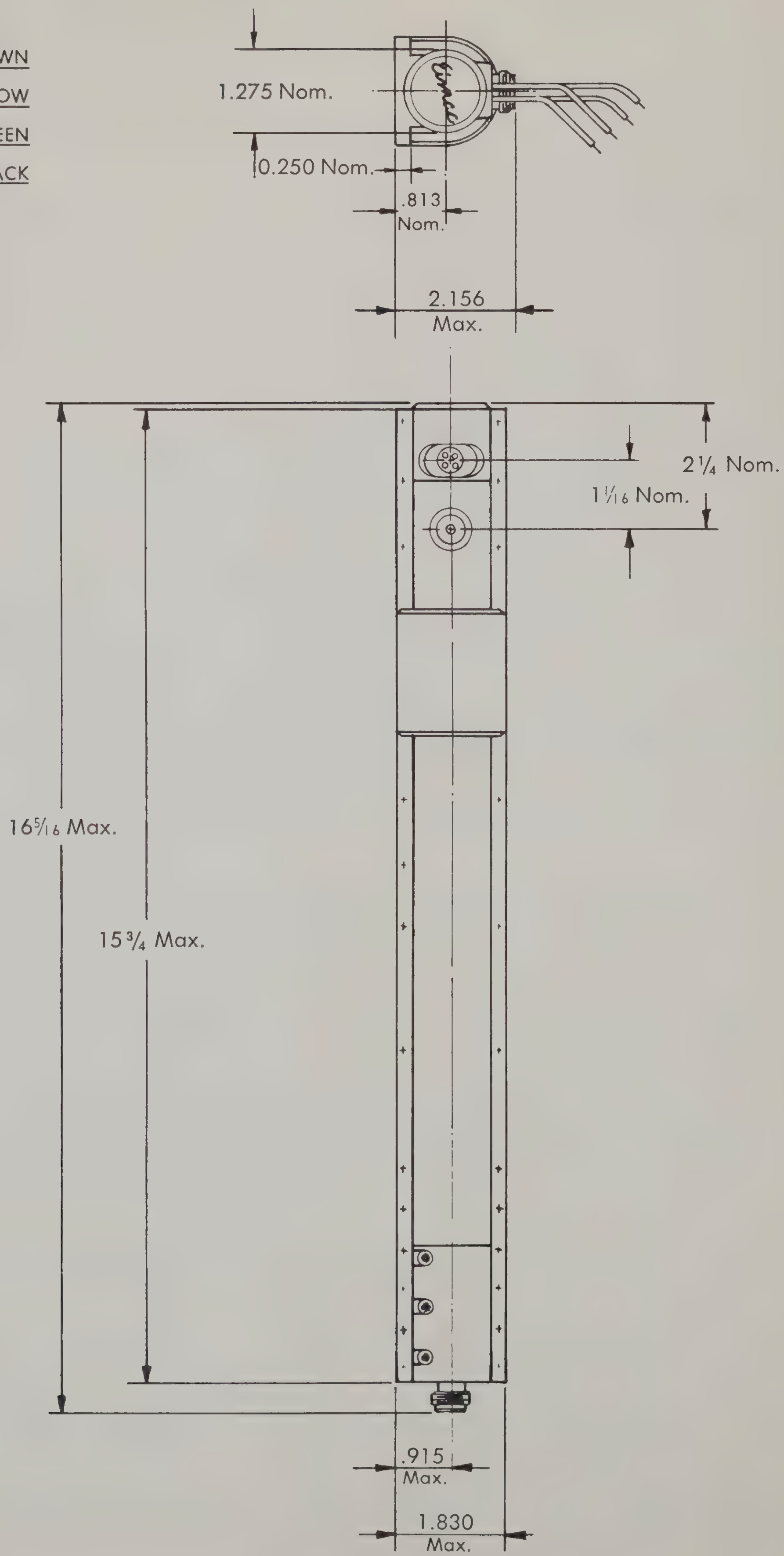




EM-1015

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-1016

TRAVELING WAVE TUBE

4.0 to 8.0 Gc.

3 Watts Min.

30 db Gain

TENTATIVE DATA FOR EIMAC EM-1016 TRAVELING WAVE TUBE

The Eimac EM-1016 is an intermediate-power traveling wave tube amplifier designed to operate in the 4.0 to 8.0 Gc frequency range. The EM-1016 will provide a minimum saturated power output of 3 watts over this frequency range with a nominal small signal gain of 30 db.

The EM-1016 features rugged ceramic and metal construction and focusing is provided by built-in periodic permanent magnets. These magnets are fully temperature compensated to allow operation from –55°C to + 85°C. No additional cooling is required at these temperatures due to the integral heat sink/mounting flange supplied with the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	4.0 to 8.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	2600 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:* NEGATIVE WITH RESPECT TO CATHODE	50 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	3.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	2550 volts
D-C Cathode Current	35 milliamperes
D-C Focus Electrode Voltage*	–40 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1016 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1016 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

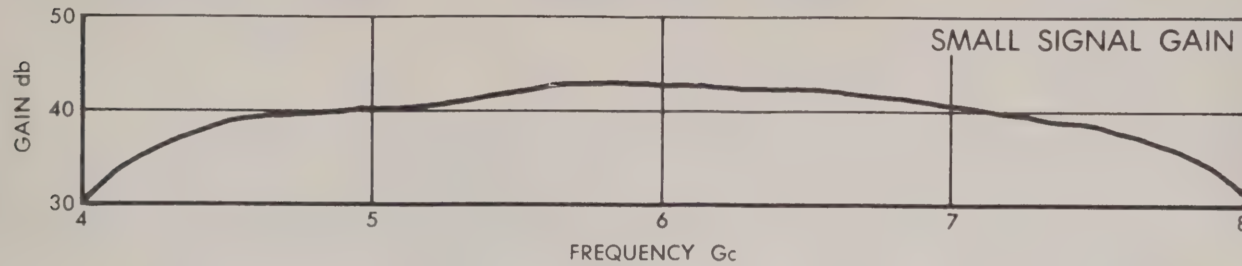
Temperature: –54°C to + 85°C

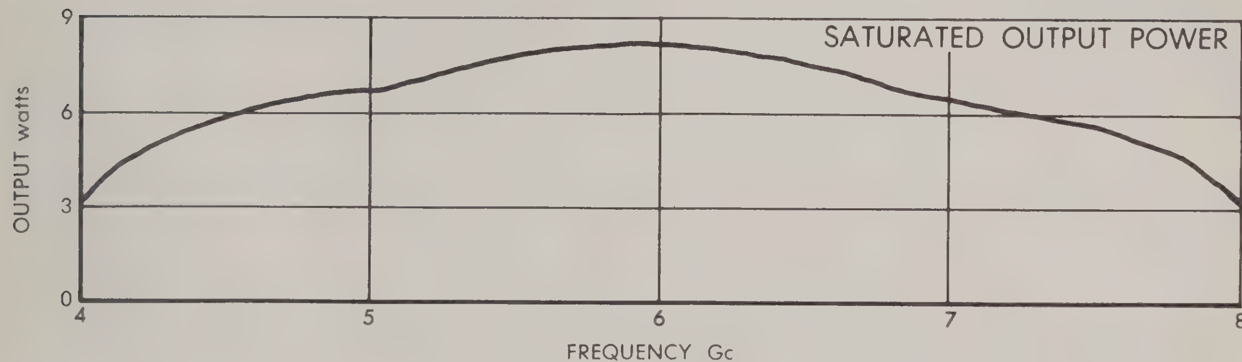
Altitude: 70,000 ft.

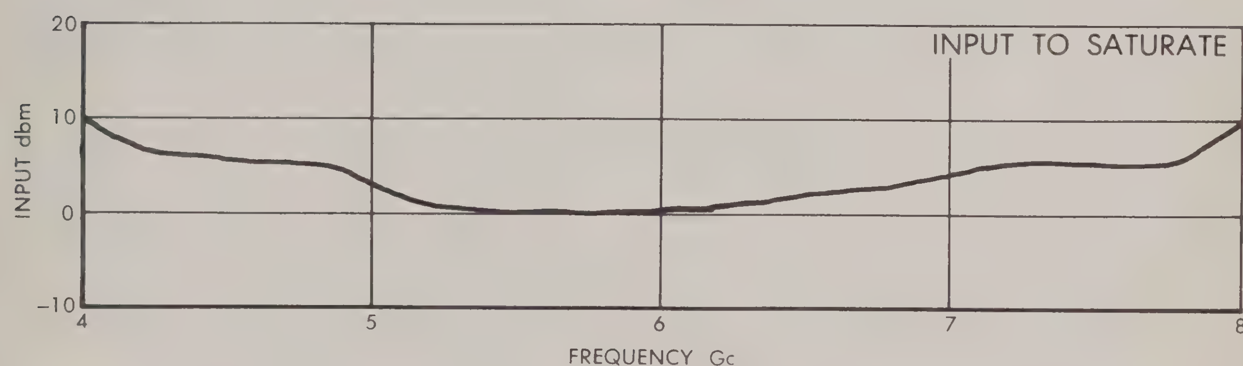
NOTE: This data should not be used for final equipment design.

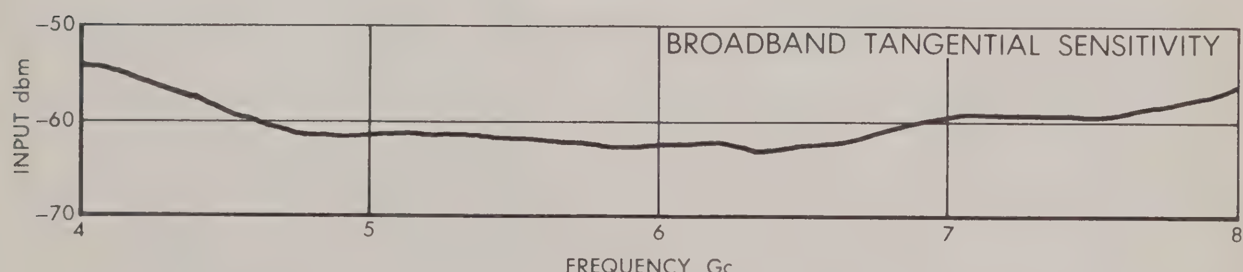
EM-1016 TYPICAL OPERATING CHARACTERISTICS

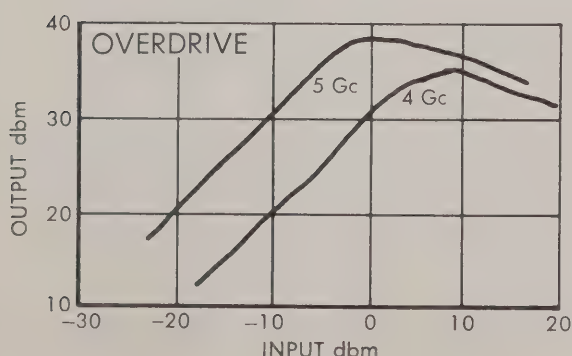
ANODE VOLTAGE 2550 Vdc
CATHODE CURRENT 35 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 V

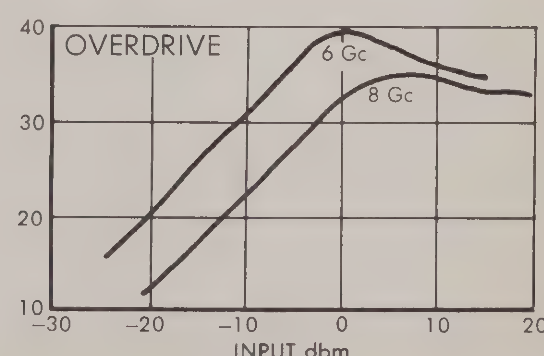








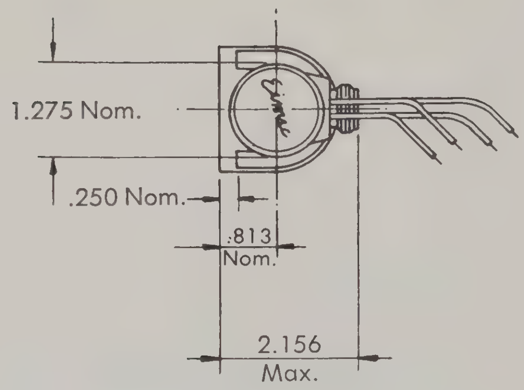


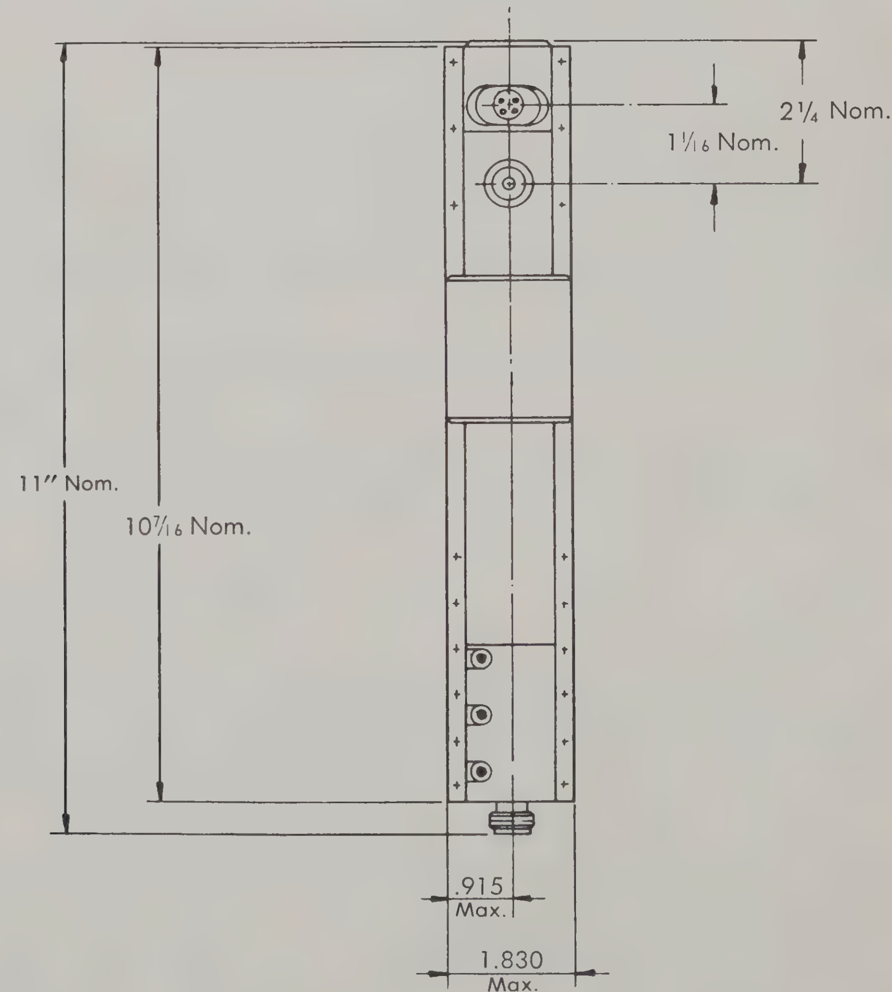


EM-1016

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





Eimac®

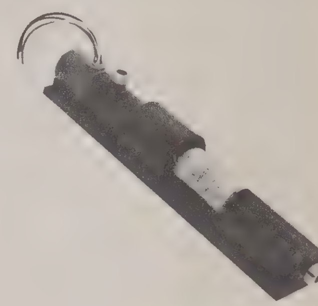
EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X-1021 TWT

4.0-8.0 GC

40 db Gain



TENTATIVE DATA FOR EIMAC X-1021 TRAVELING WAVE TUBE

The Eimac X-1021 is a C-Band, ruggedized, light weight power amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperatures. The X-1021 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 10 watts and 40 db gain over the frequency range of 4.0 to 8.0 Gc.

APPLICATIONS

The all ceramic-metal design coupled with a temperature compensated periodic permanent magnet array enables the X-1021 to perform under adverse environmental conditions while heat sink cooling provides an improved form factor for equipment design, making it an excellent choice for power amplification in augmentation or ECM systems in high performance aircraft, rocket or missile applications.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode.	Unipotential, dispenser type	
	Minimum Heating Time	120 seconds
Heater:	Voltage	6.3 volts
	Current	1.2 amperes
Noise Figure		35 decibels
Minimum Saturated Output Power		10 watts
Minimum Saturated Gain		40 db
Frequency Range		4.0 to 8.0 gigacycles
Input and Output Impedance		50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Heat Sink and/or Forced Air
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	3.5 Pounds

Effective 1 August 1962

MAXIMUM RATINGS

D-C Beam Voltage*	2900 volts
D-C Focus Electrode Voltage*:	
Negative with respect to cathode	
(a) For CW Operation	40 volts
(b) For maximum current control	400 volts
D-C Cathode Current	90 milliamperes

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	10 watts
Minimum Saturated Gain	40 decibels
D-C Beam Voltage*	2850 volts
D-C Cathode Current	80 milliamperes
D-C Focus Electrode Voltage*	—30 volts
D-C Focus Electrode Current	1.0 milliamperes

*All voltages referred to cathode

APPLICATION

Cooling: The X-1021 is designed to be cooled by means of conduction to the mounting flange integral with the tube and PPM structure, or by forced air directed across the collector. Adequate cooling is determined when the envelope temperature is maintained below 250°F by thermocouple measurements at monitoring point indicated.

Cathode: The heater voltage should be maintained within ±5 percent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

HELIX: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials.

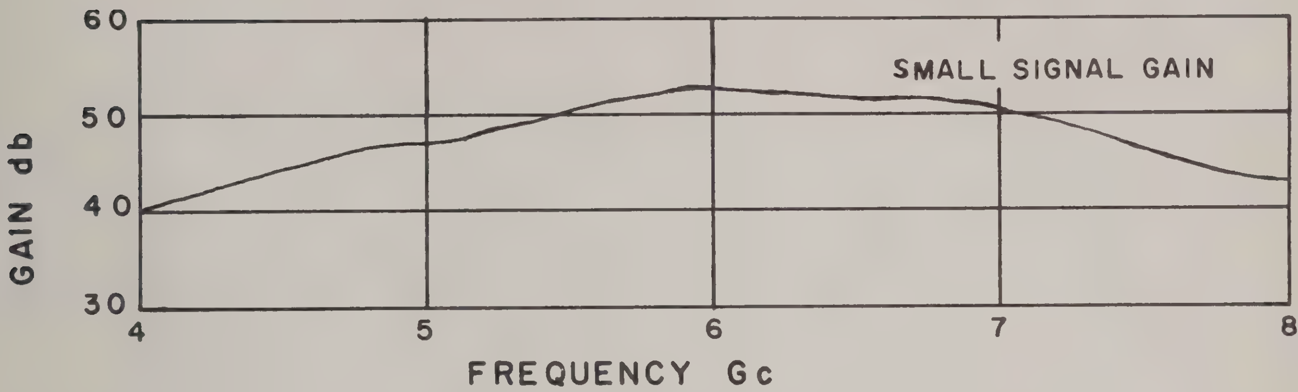
Focus Electrode: The focus electrode power supply must be regulated within ±2 percent to minimize variations in performance. This electrode may be used as a cathode current control electrode, within the limits of the maximum ratings listed above.

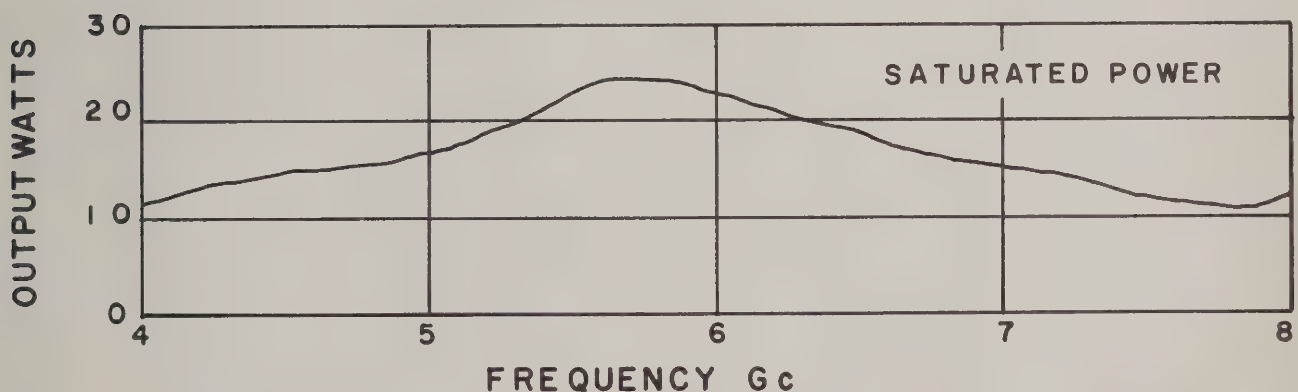
Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, Telephone LYtell 1-1451, Cable: EIMAC.

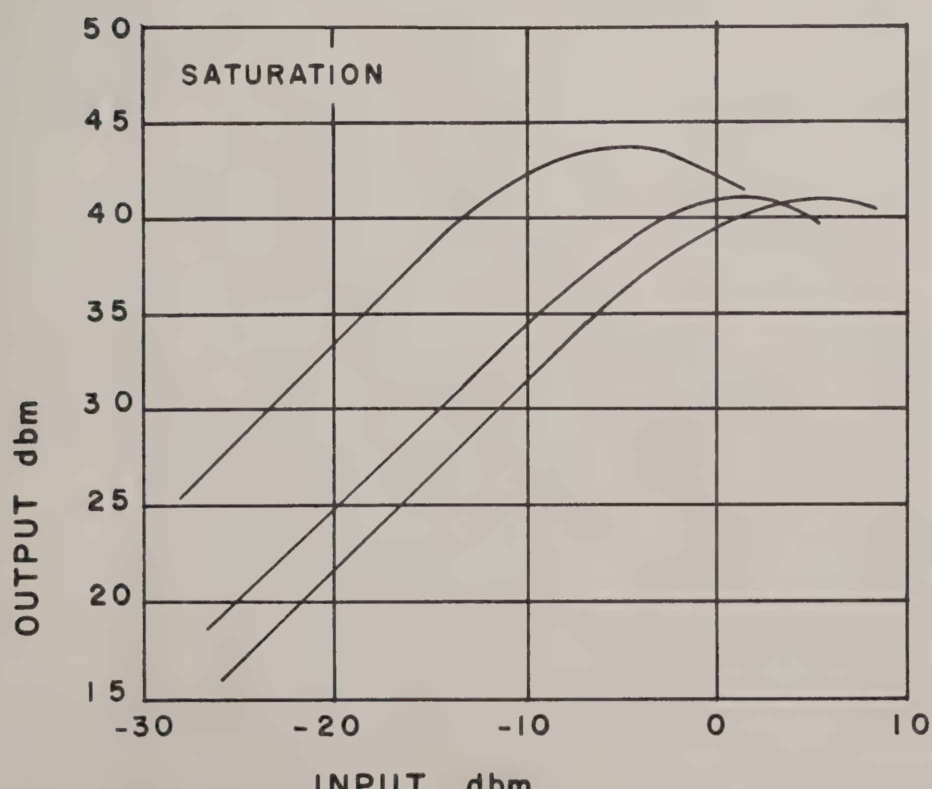
EM 1021 TYPICAL OPERATING CHARACTERISTICS

HELIX VOLTAGE 2850 Vdc FOCUS VOLTAGE -30 Vdc

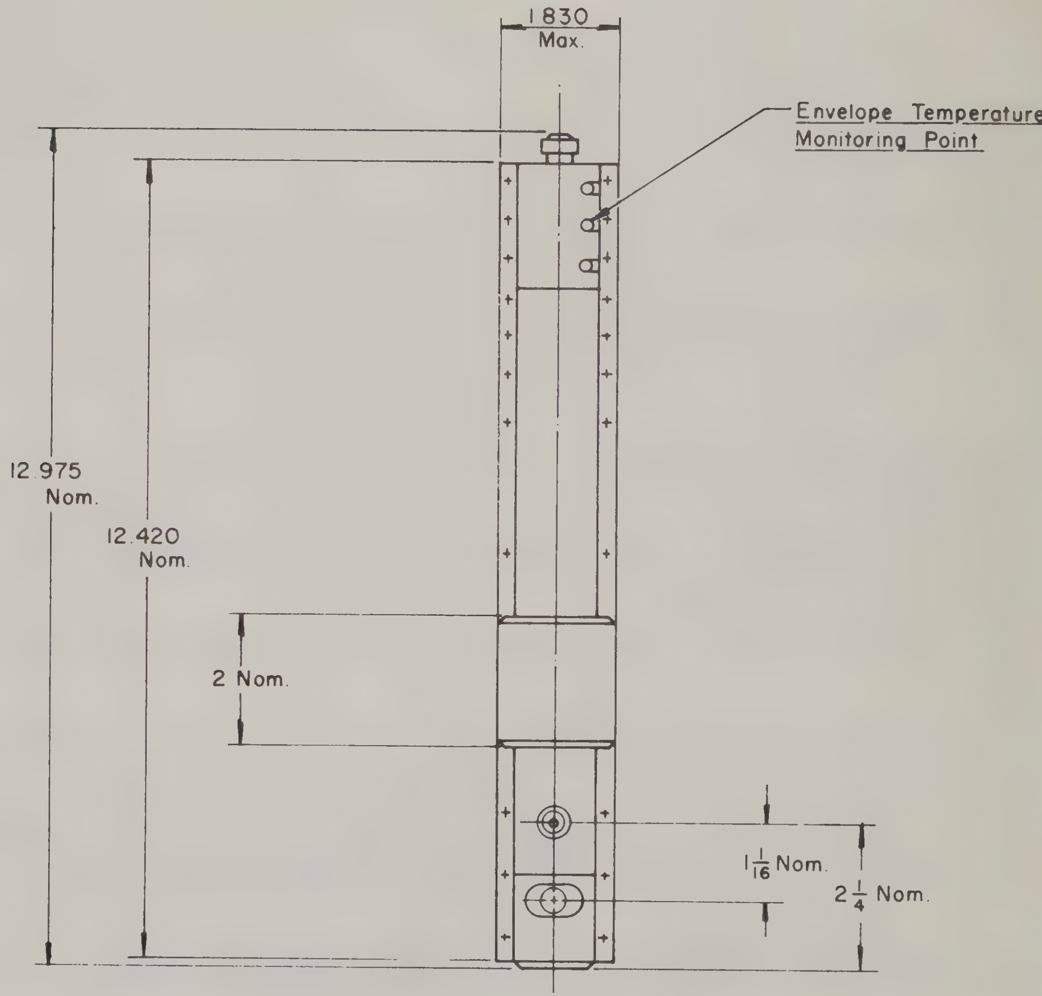
CATHODE CURRENT 80 mAdc FILAMENT 6.3 V





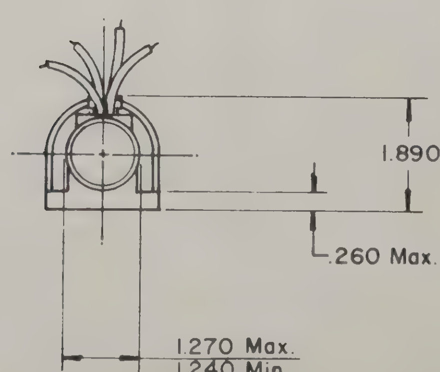


X1021



CONNECTIONS

1. HEATER -BROWN
2. CATHODE HEATER -YELLOW
3. FOCUS ELECTRODE -GREEN
4. BODY GROUND -BLACK



Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

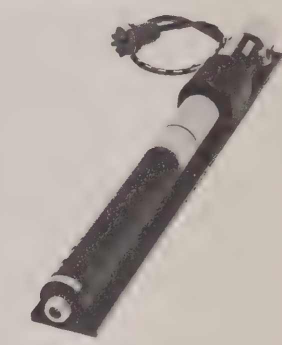
EM-1025

TRAVELING WAVE TUBE

4.0 to 12.0 Gc.

1 Watt Min.

40 db Gain



TENTATIVE DATA FOR EIMAC EM-1025 TRAVELING WAVE TUBE

The Eimac EM-1025 now offers performance over a frequency range that previously required **two or more** tubes to duplicate, providing 1 watt saturated power output from 4.0 to 12.0 gigacycles with 40 db gain! This tube is focused by light weight, periodic permanent magnets and utilizes proven ceramic and metal construction to insure reliable operation over a wide range of environments. The integral heat sink/mounting flange allows operation to + 85°C without additional cooling.

APPLICATIONS:

Wide bandwidth, high power output and high gain make the EM-1025 ideally suited for signal generators, power amplifier units or any application where these characteristics are required. In addition, the tube can be adapted to frequency-multiplier applications.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	4.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 12.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	40 decibels
D-C Beam Voltage*	2900 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1025 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1025 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

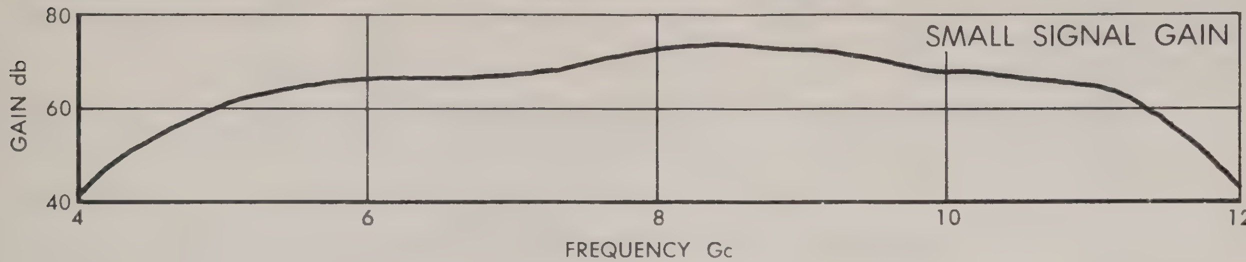
Temperature: –54°C to + 85°C

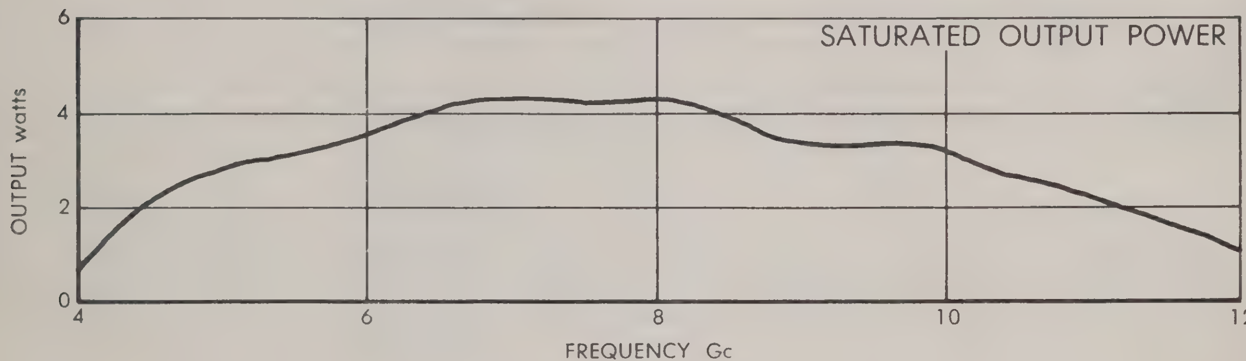
Altitude: 70,000 ft.

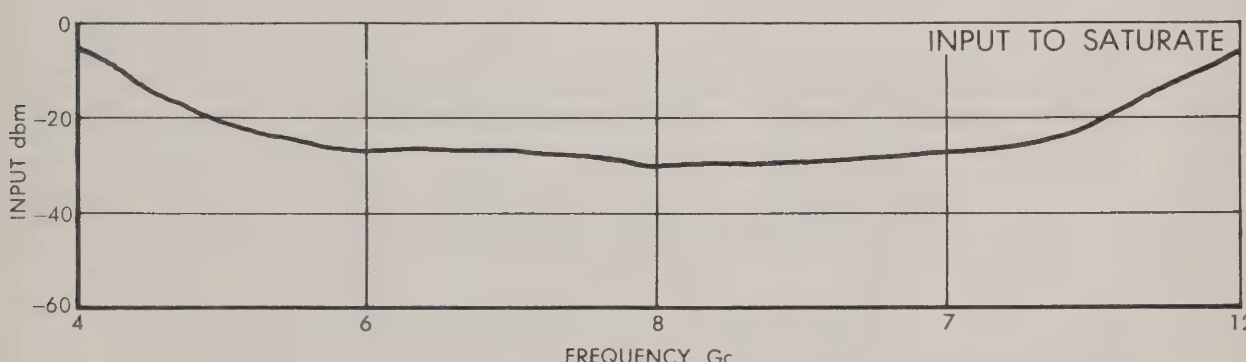
NOTE: This data should not be used for final equipment design.

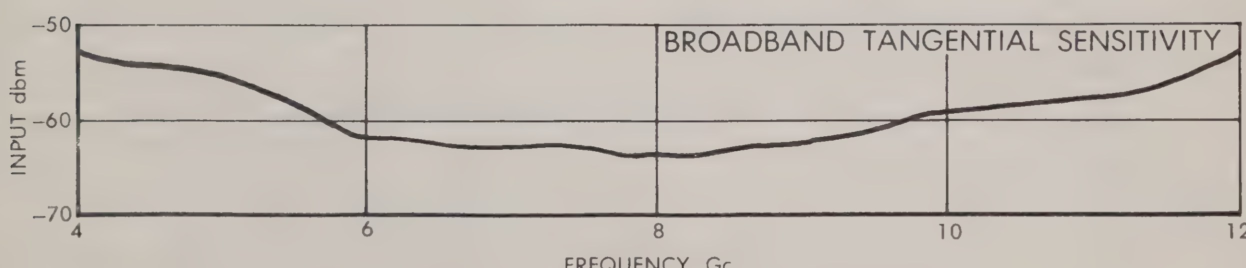
EM-1025 TYPICAL OPERATING CHARACTERISTICS

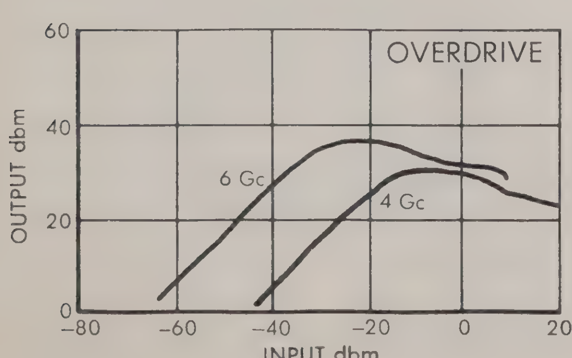
ANODE VOLTAGE	2900 Vdc	FOCUS VOLTAGE	–30 Vdc
CATHODE CURRENT	23 mAdc	FILAMENT VOLTAGE	6.3 V

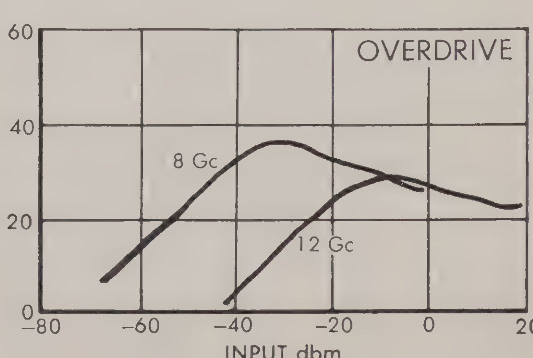








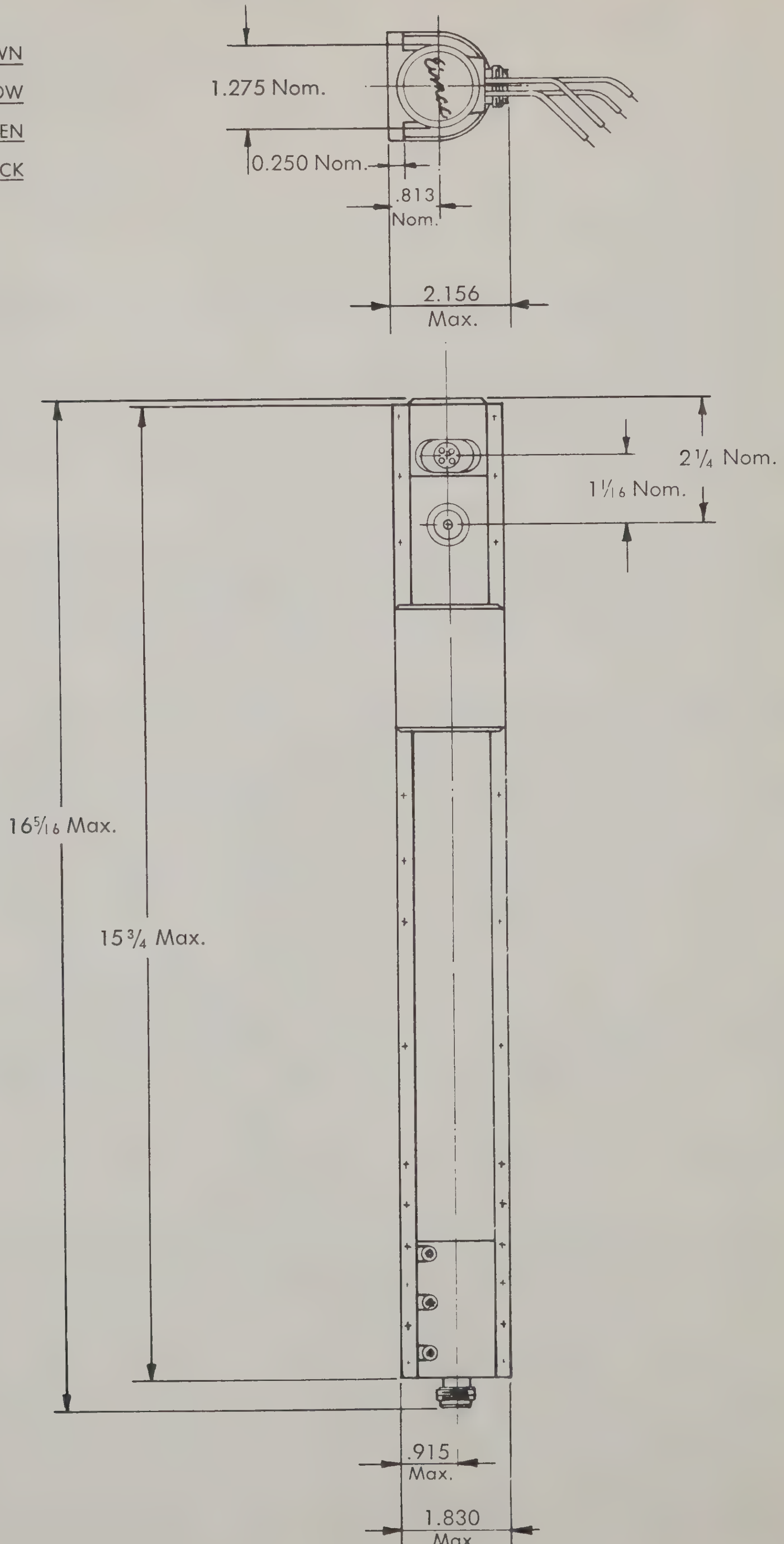




EM-1025

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.

TENTATIVE DATA

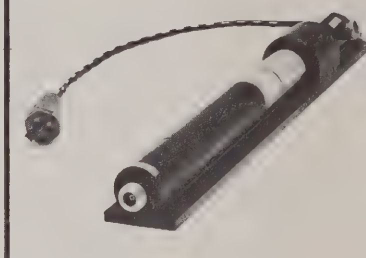
EM-1030

TRAVELING WAVE TUBE

7.0 to 11.0 Gc.

5 Watts Min.

60 db Gain



TENTATIVE DATA FOR EIMAC EM-1030 TRAVELING WAVE TUBE

The Eimac EM-1030 is a broadband, high gain traveling wave amplifier designed to operate in the frequency range of 7.0 to 11.0 Gc with a minimum saturated power output of 5 watts. Rugged metal-ceramic construction permits operation at high ambient temperatures and under severe environmental extremes of shock, vibration and altitude.

Focusing is provided by light weight, periodic permanent magnets which are fully temperature-compensated to allow operation from –55 to + 85°C. The integral heat sink/mounting flange permits this high temperature operation without additional cooling required for most applications.

APPLICATIONS:

Wide bandwidth, high power output and very high gain make the EM-1030 an ideal choice for radar augmentation or ECM applications in high performance aircraft or missile systems.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	5 watts
Frequency Range	7.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3400 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	7.0 to 11.0 gigacycles
Minimum Output Power	5.0 watts
Small Signal Gain	60 decibels
D-C Beam Voltage*	3350 volts
D-C Cathode Current	34 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1030 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1030 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

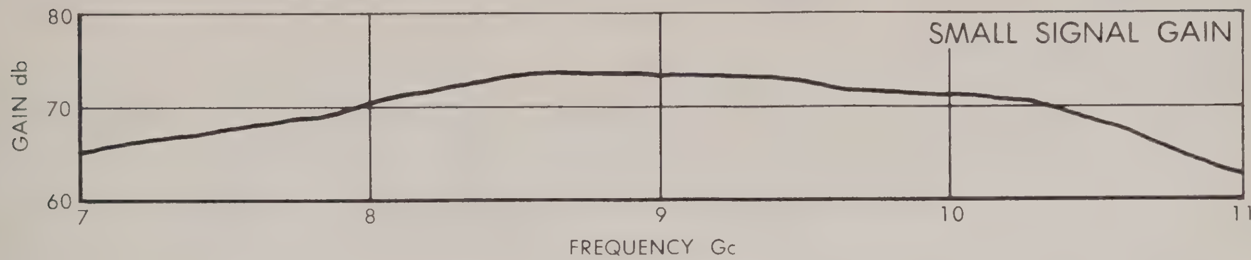
Temperature: –54°C to + 85°C

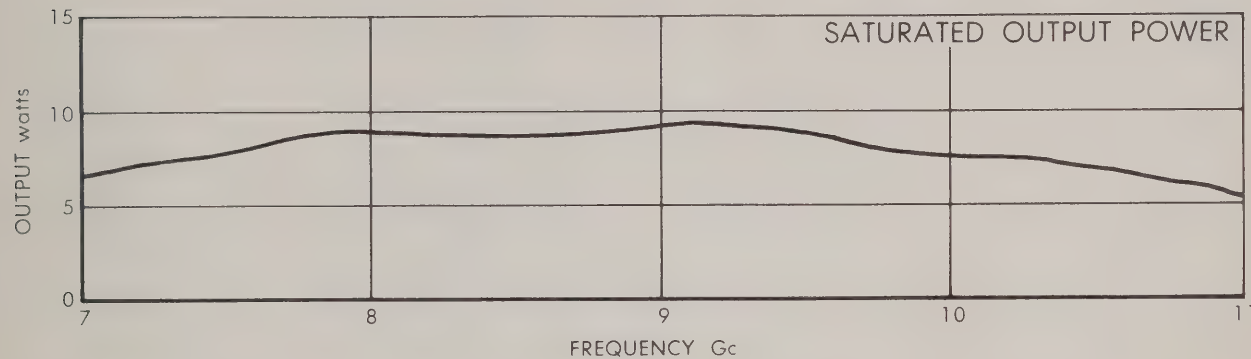
Altitude: 70,000 ft.

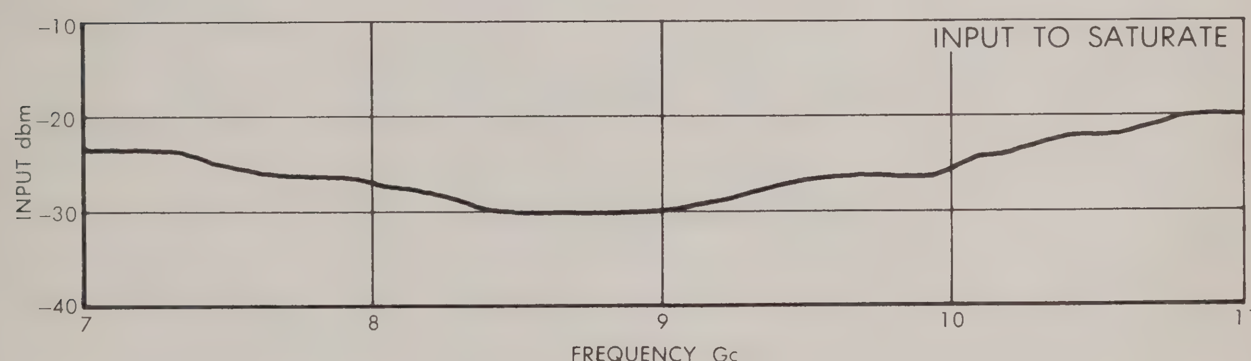
NOTE: This data should not be used for final equipment design.

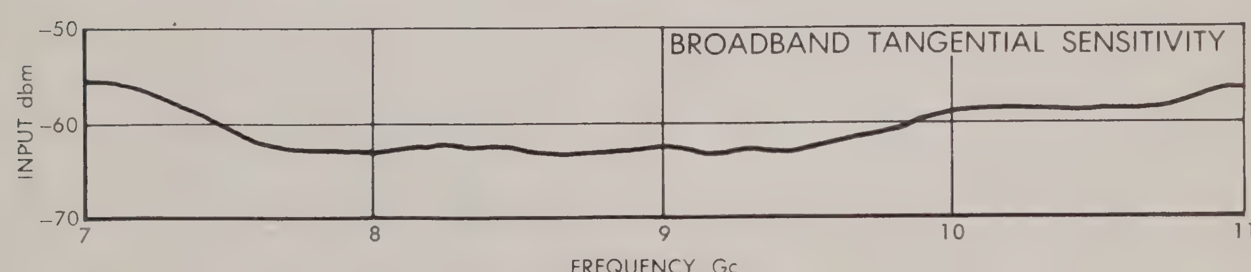
EM-1030 TYPICAL OPERATING CHARACTERISTICS

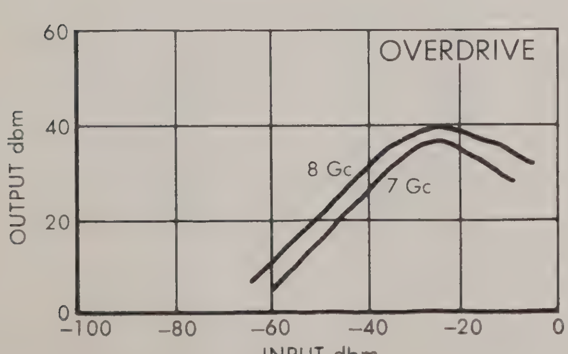
ANODE VOLTAGE	3350 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURRENT	34 mAdc	FILAMENT VOLTAGE	6.3 V

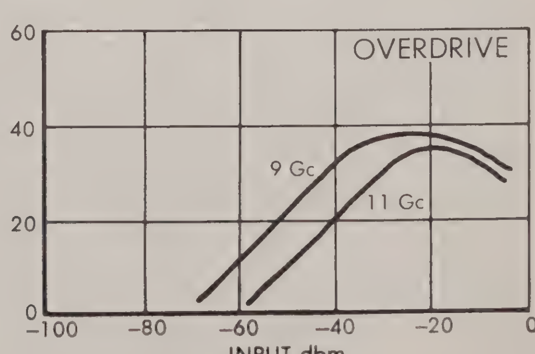








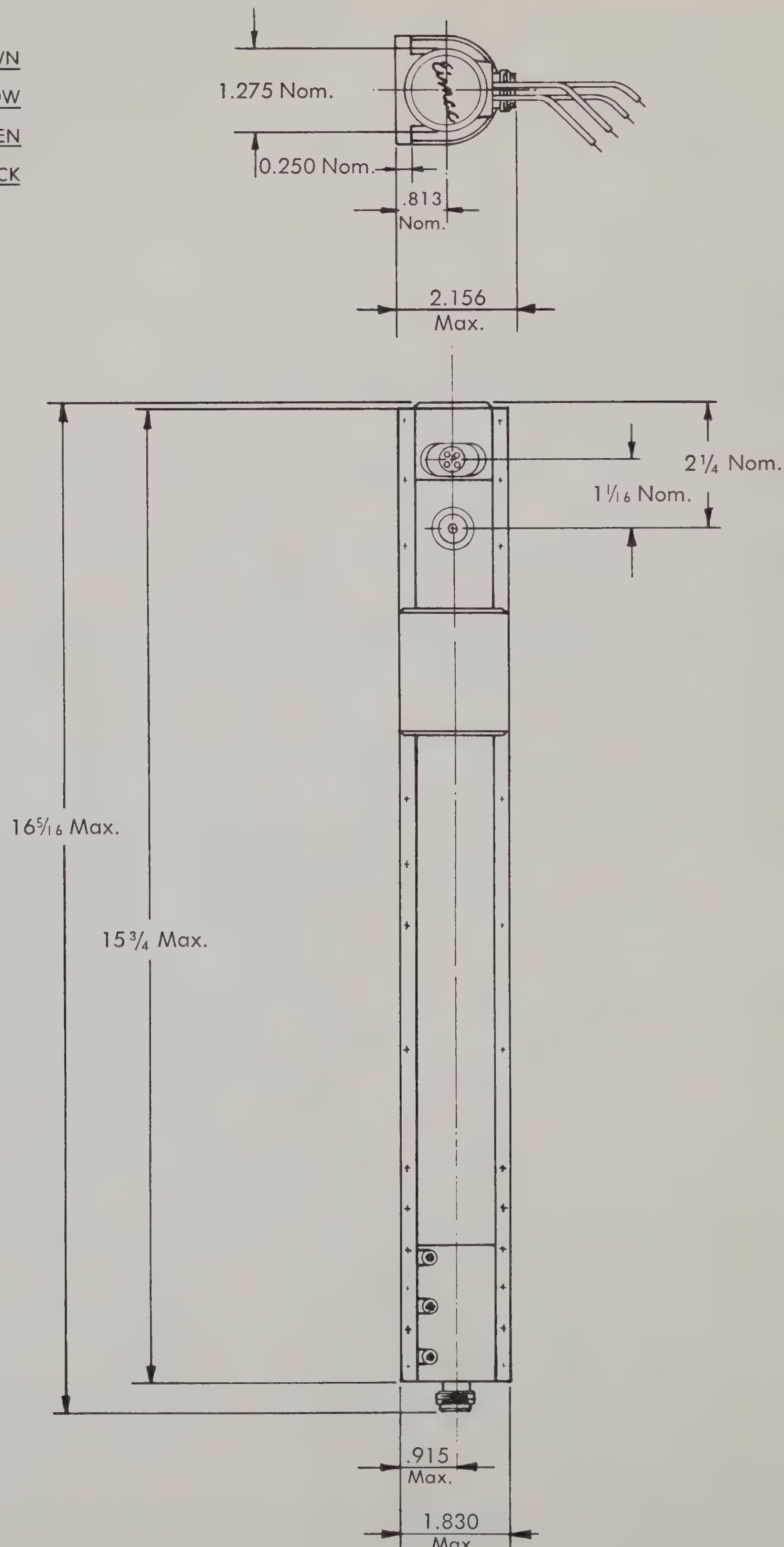




EM-1030

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



Eimac®

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-1031

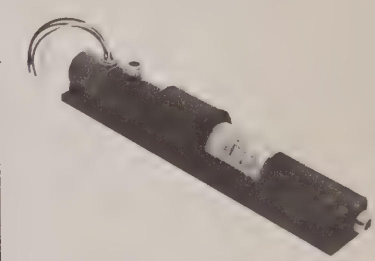
TRAVELING WAVE TUBE

7.0 to 11.0 Gc.

5 Watts Min.

30 db Gain

TENTATIVE DATA FOR EIMAC EM-1031 TRAVELING WAVE TUBE



The Eimac EM-1031 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM-1031 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 5 watts CW over the frequency range of 7.0 to 11.0 Gc with a nominal small signal gain of 30 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of + 85°C without additional cooling. Flexible leads provide electrical connections to the tube. The integral heat sink/mounting flange permits this high temperature operation without additional cooling required for most applications.

APPLICATIONS:

Wide bandwidth, high power output and high gain make the EM-1031 ideally suited for radar augmentation or ECM applications in high performance aircraft or missile systems.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	5 watts
Frequency Range	7.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3400 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	7.0 to 11.0 gigacycles
Minimum Output Power	5.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	3350 volts
D-C Cathode Current	34 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1031 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

The EM-1031 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

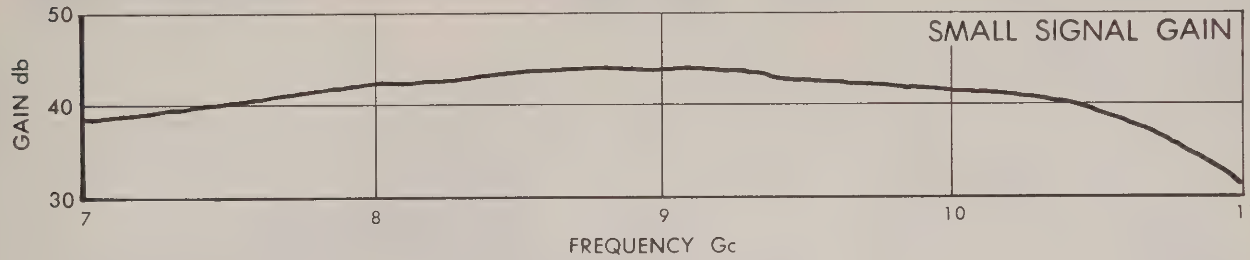
Temperature: –54°C to + 85°C

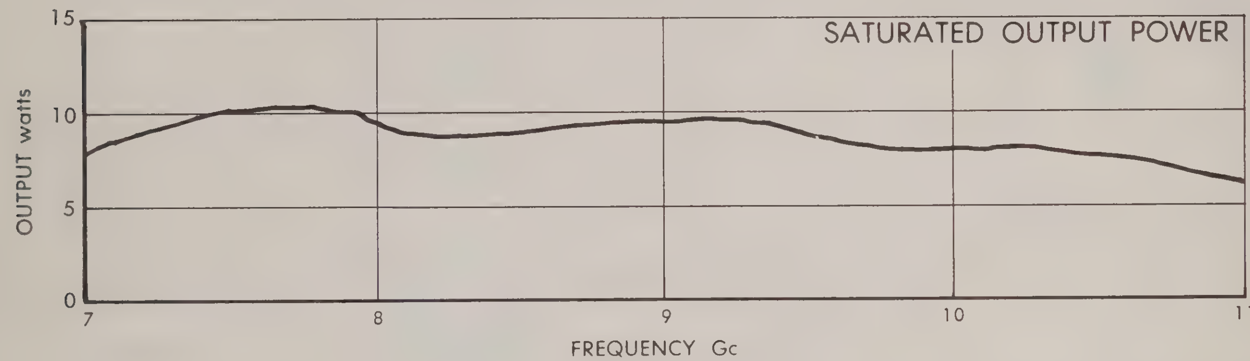
Altitude: 70,000 ft.

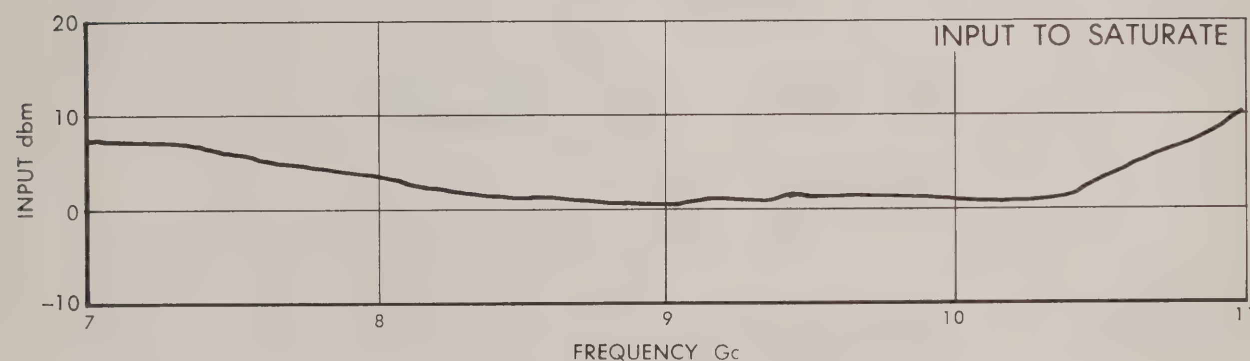
NOTE: This data should not be used for final equipment design.

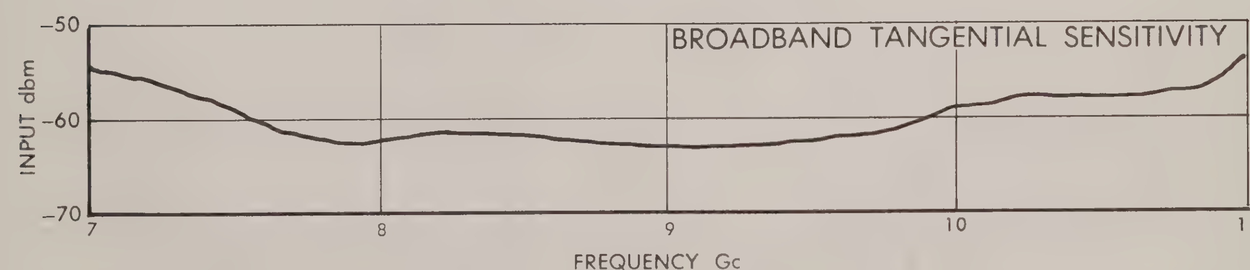
EM-1031 TYPICAL OPERATING CHARACTERISTICS

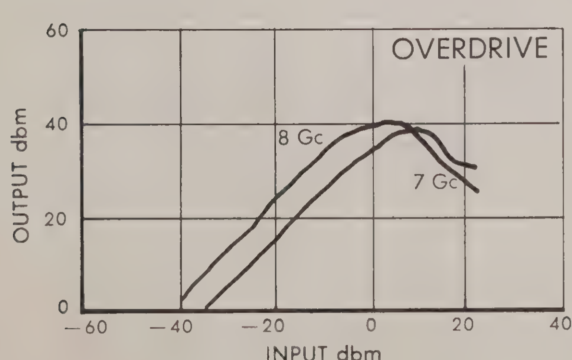
ANODE VOLTAGE 3350 Vdc
CATHODE CURRENT 34 mAdc
FOCUS VOLTAGE −30 Vdc
FILAMENT VOLTAGE 6.3 V

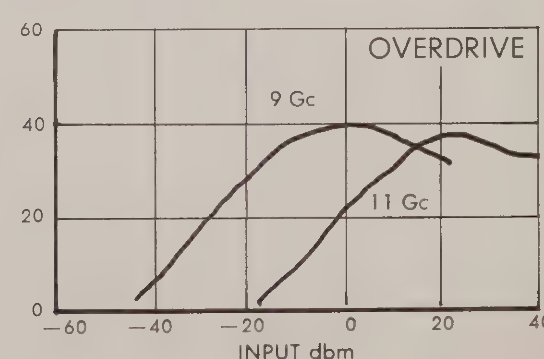








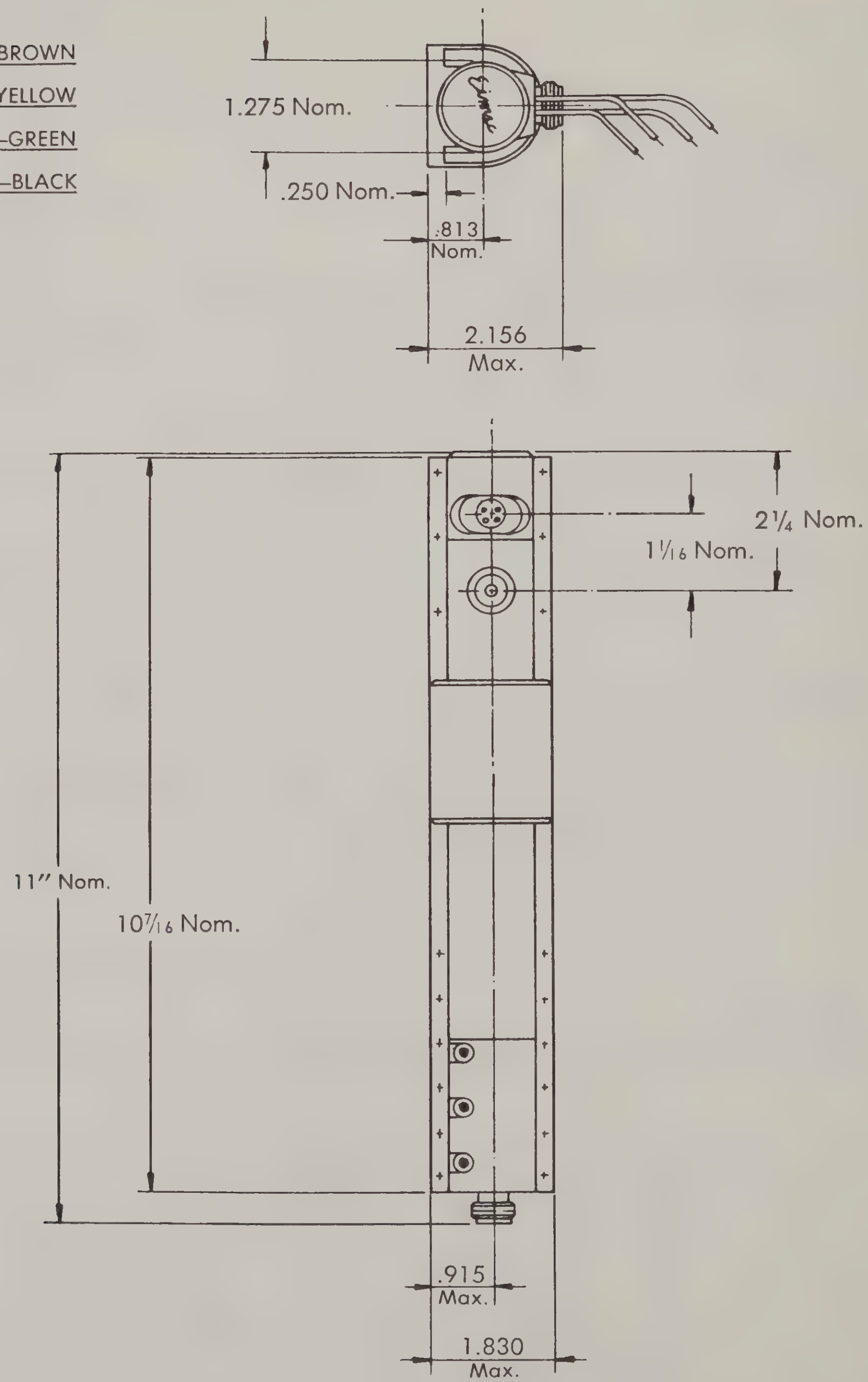




EM-1031

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1045

TRAVELING WAVE TUBE

8.0 to 12.0 Gc.

1 Watt Min.

60 db Gain

TENTATIVE DATA FOR EIMAC EM-1045 TRAVELING WAVE TUBE

The Eimac EM-1045 is a broadband, high gain traveling wave amplifier designed to operate in the frequency range of 8.0 to 12.0 Gc with a nominal saturated power output of 1 watt. Rugged metal-ceramic construction permits operation at high extremes of shock, vibration and altitude.

Focusing is provided by light weight, periodic permanent magnets which are fully temperature-compensated to allow operation from –55°C to + 85°C.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	8.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	60 decibels
D-C Beam Voltage*	2950 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1045 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1045 conforms generally with MIL-E-5272C, "Environmental Testing, Areonautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

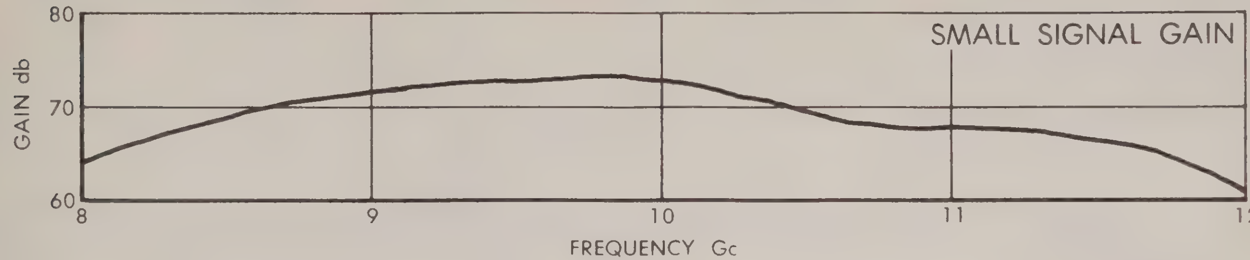
Temperature: –54°C to + 85°C

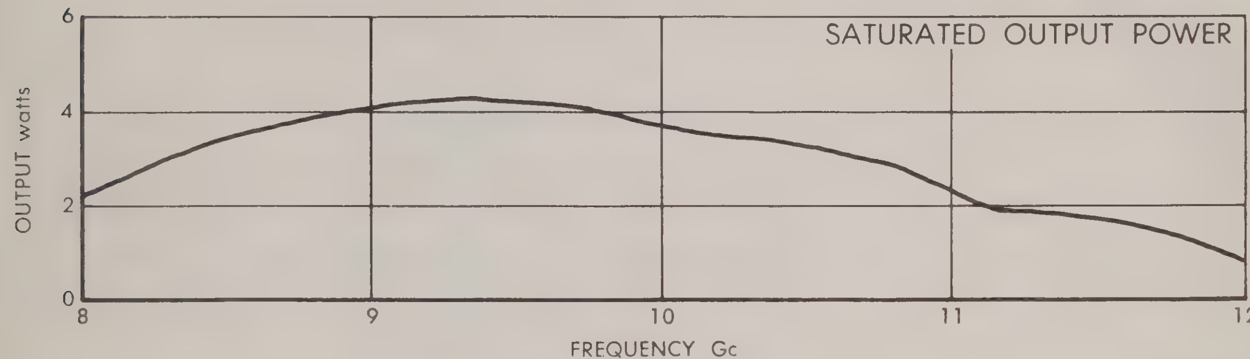
Altitude: 70,000 ft.

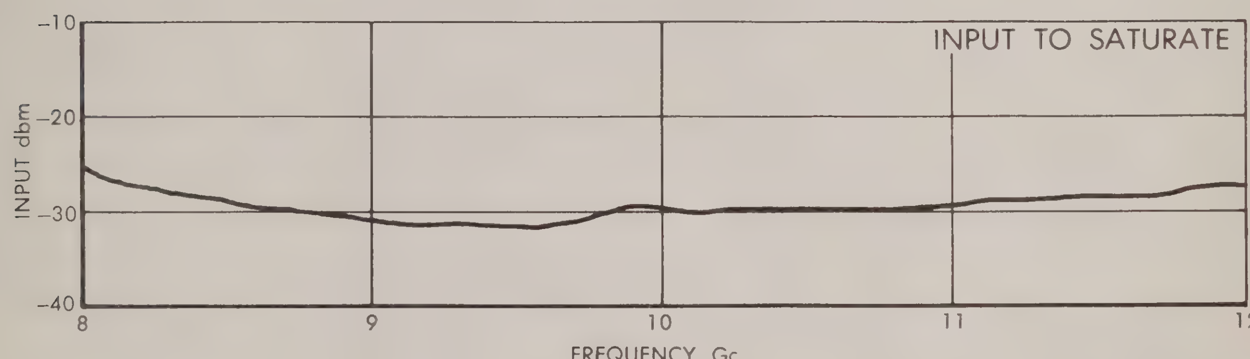
NOTE: This data should not be used for final equipment design.

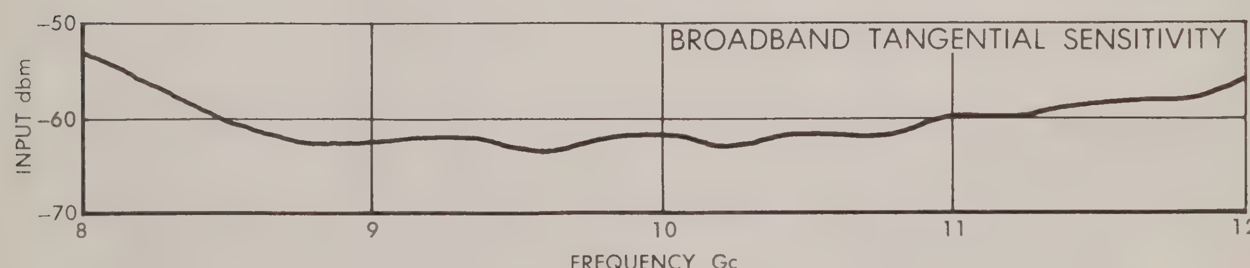
EM-1045 TYPICAL OPERATING CHARACTERISTICS

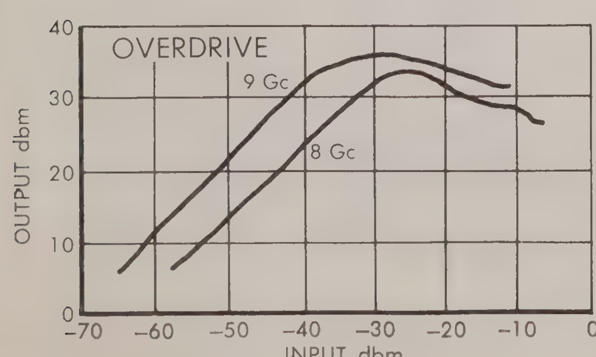
ANODE VOLTAGE	2950 Vdc	FOCUS VOLTAGE	–30 Vdc
CATHODE CURENT	23 mAdc	FILAMENT VOLTAGE	6.3 Vac

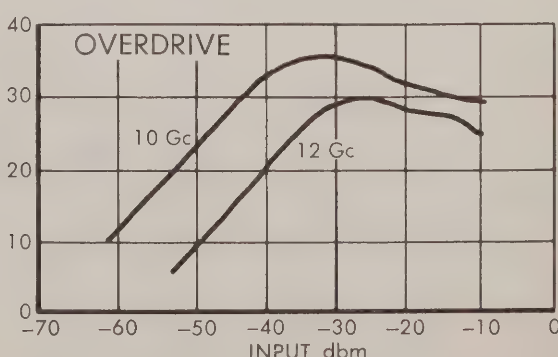








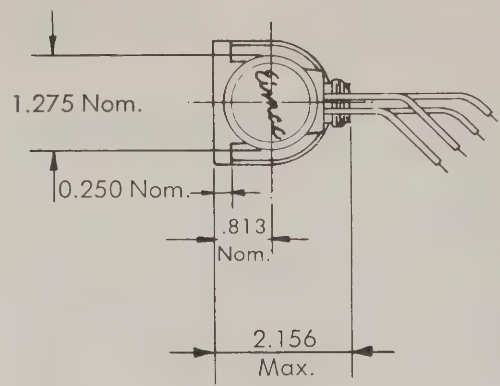


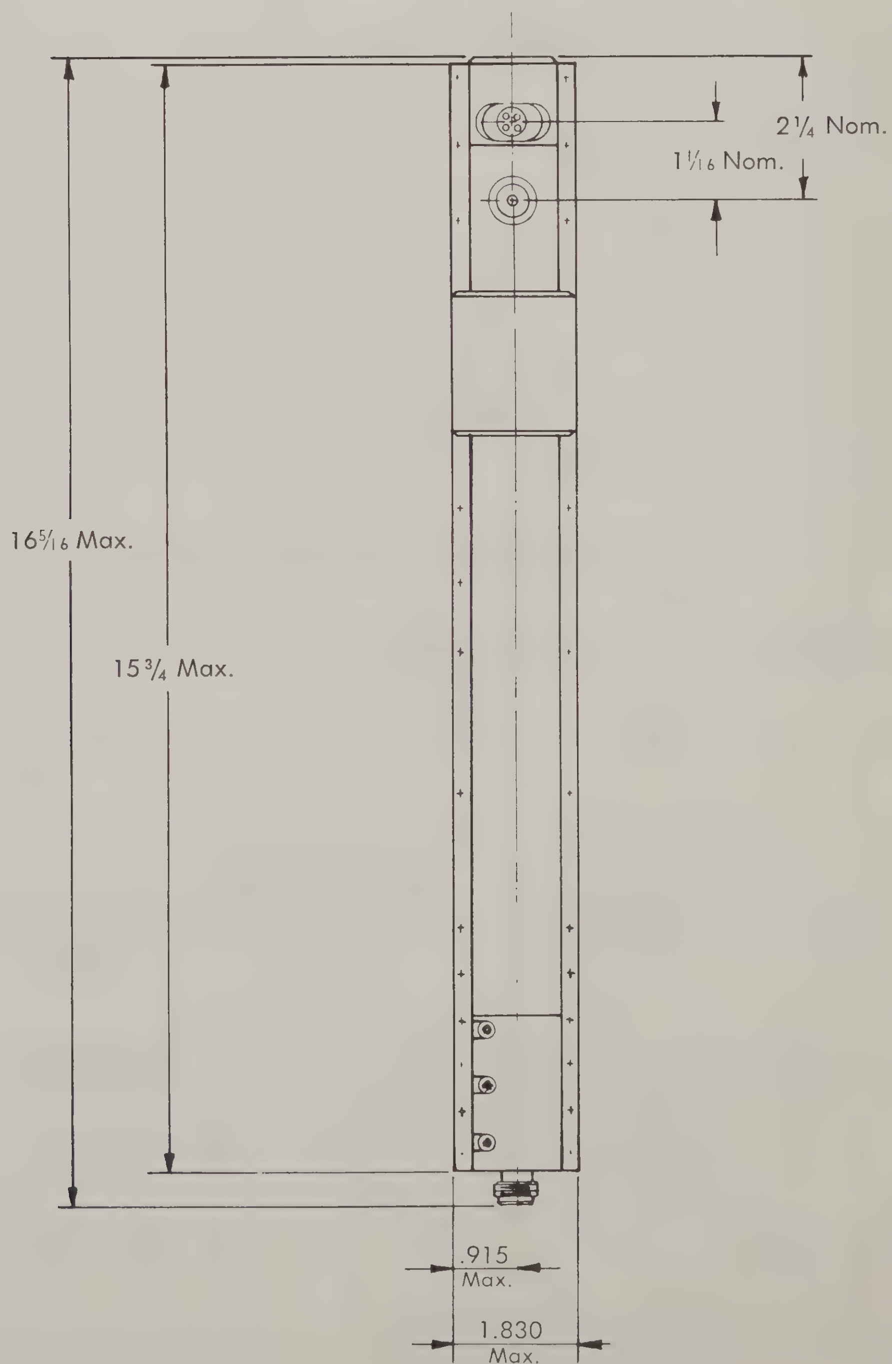


EM-1045

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





Eimac®

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-1046

TRAVELING WAVE TUBE

8.0 to 12.0 Gc.

1 Watt Min.

30 db Gain

TENTATIVE DATA FOR EIMAC EM-1046 TRAVELING WAVE TUBE

The Eimac EM-1046 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of 1 watt throughout the frequency range of 8.0 to 12.0 gigacycles with a nominal small signal gain of 30 decibels. The EM-1046 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the EM-1046 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	8.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	30 decibels
D-C Beam Voltage*	2950 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1046 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1046 conforms generally with MIL-E-5272C, "Environmental Testing, Areonautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

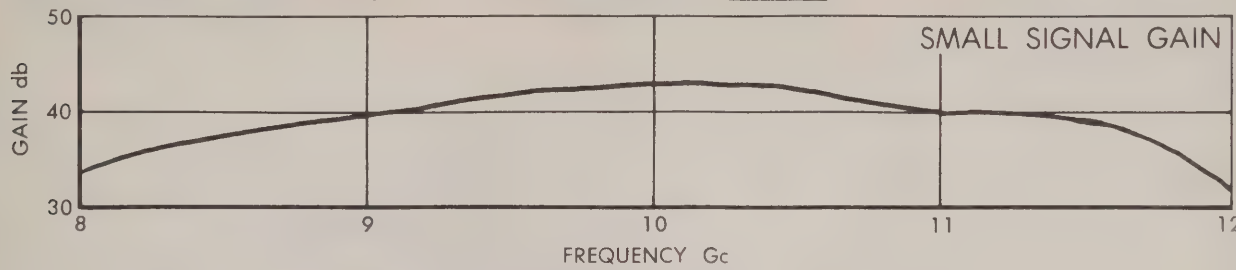
Temperature: –54°C to + 85°C

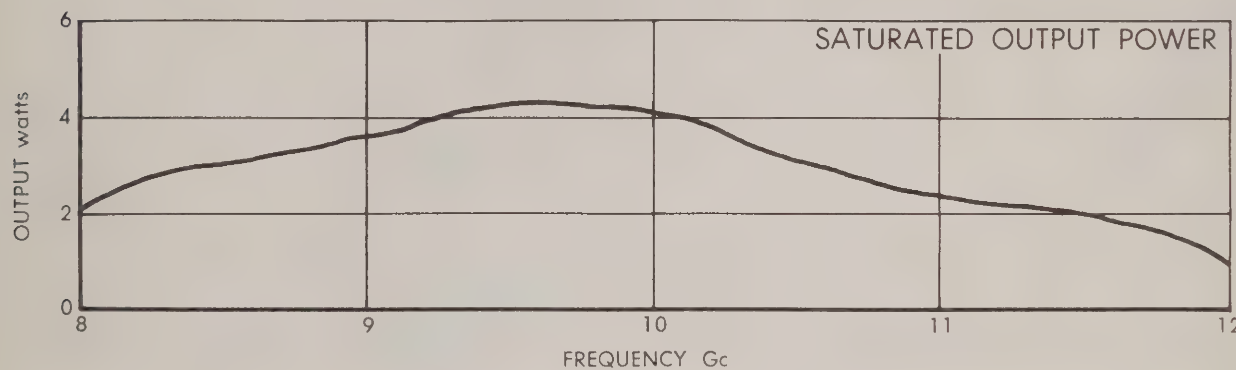
Altitude: 70,000 ft.

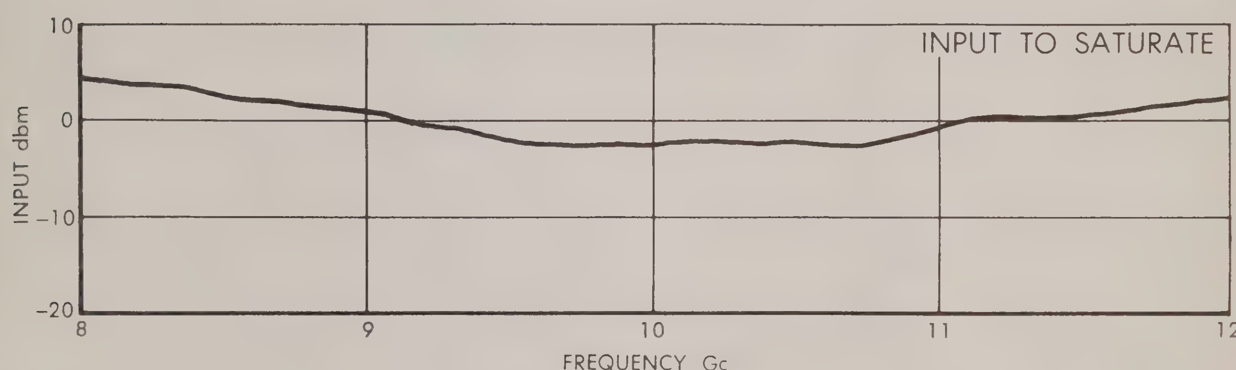
NOTE: This data should not be used for final equipment design.

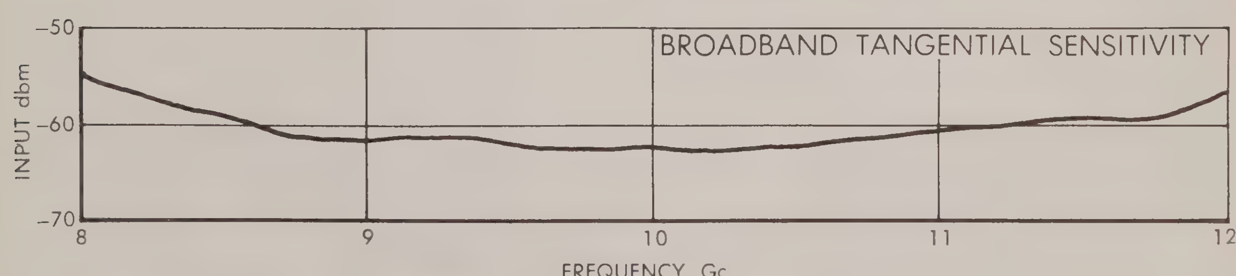
EM-1046 TYPICAL OPERATING CHARACTERISTICS

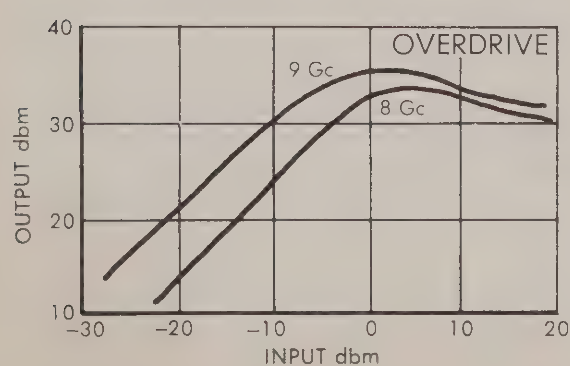
ANODE VOLTAGE 2950 Vdc
CATHODE CURENT 23 mAdc
FOCUS VOLTAGE −30 Vdc
FILAMENT VOLTAGE 6.3 Vac

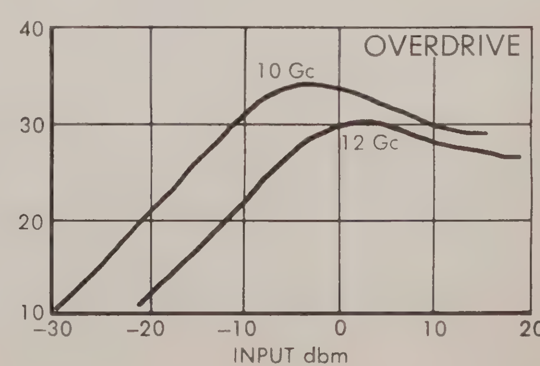








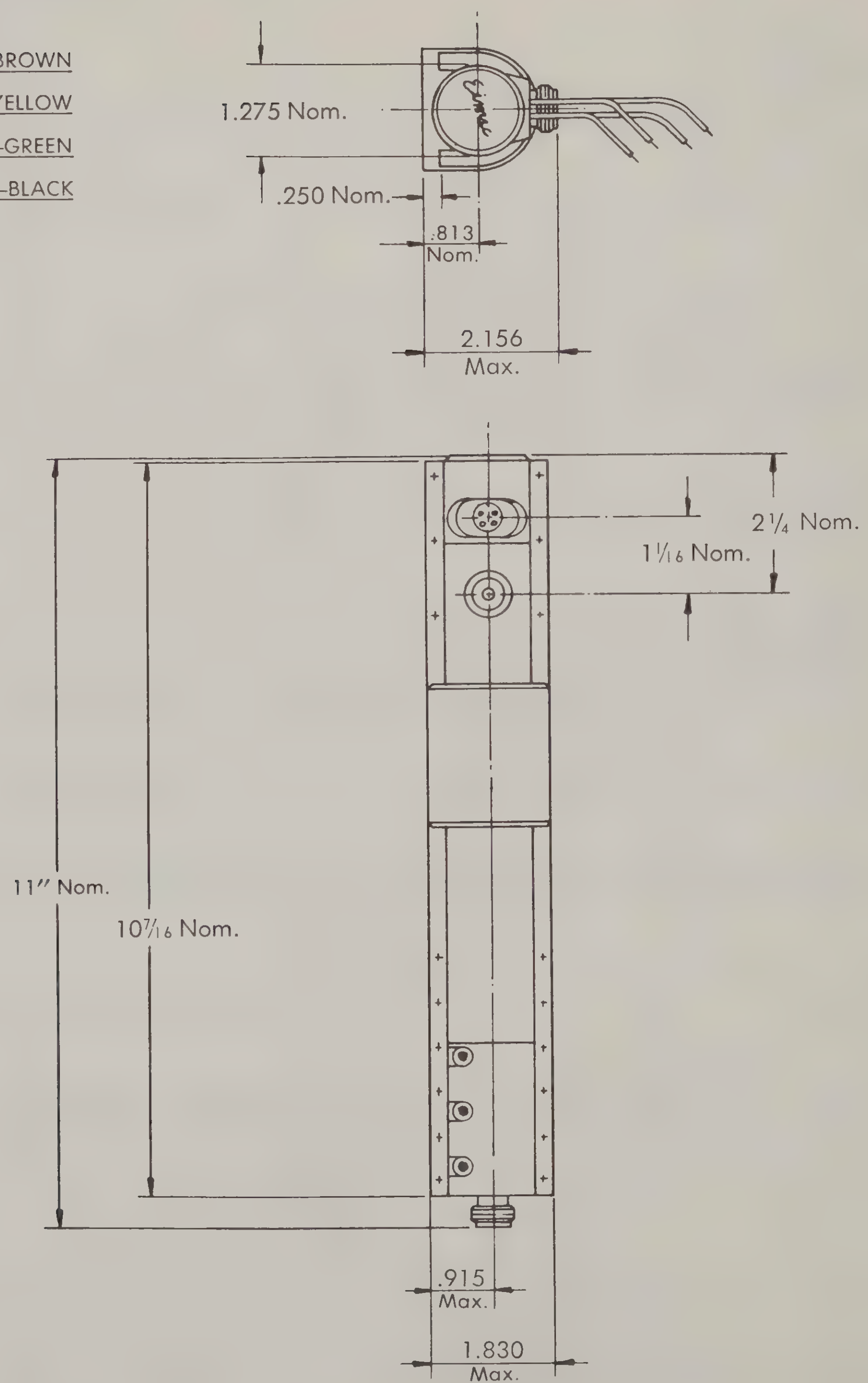




EM-1046

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.

TENTATIVE DATA

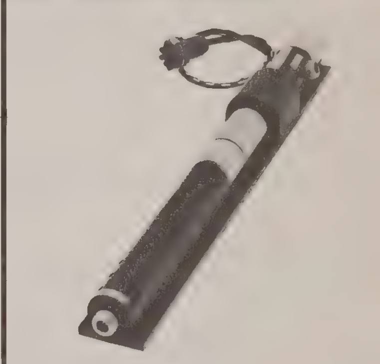
EM-1050

TRAVELING WAVE TUBE

8.0 to 12.0 Gc.

3 Watts Min.

60 db Gain



TENTATIVE DATA FOR EIMAC EM-1050 TRAVELING WAVE TUBE

The Eimac EM-1050 is an intermediate-power traveling wave tube amplifier designed to operate in the 8.0 to 12.0 Gc frequency range. The EM-1050 will provide a minimum saturated power output of 3 watts over this frequency range with a nominal small signal gain of 60 db.

The EM-1050 features rugged ceramic and metal construction and focusing is provided by built-in periodic permanent magnets. These magnets are fully temperature compensated to allow operation from –55 to + 85°C. No additional cooling is required at these temperatures due to the integral heat sink/mounting flange supplied with the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	8.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3500 VOLTS
D-C FOCUS ELECTRODE VOLTAGE* NEGATIVE WITH RESPECT TO CATHODE	50 VOLTS
D-C CATHODE CURRENT	30 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigacycles
Minimum Output Power	3.0 watts
Small Signal Gain	60 decibels
D-C Beam Voltage*	3300 volts
D-C Cathode Current	28 milliamperes
D-C Focus Electrode Voltage*	–40 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1050 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1050 conforms generally with MIL-E-5272C, "Environmental Testing, Areonautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

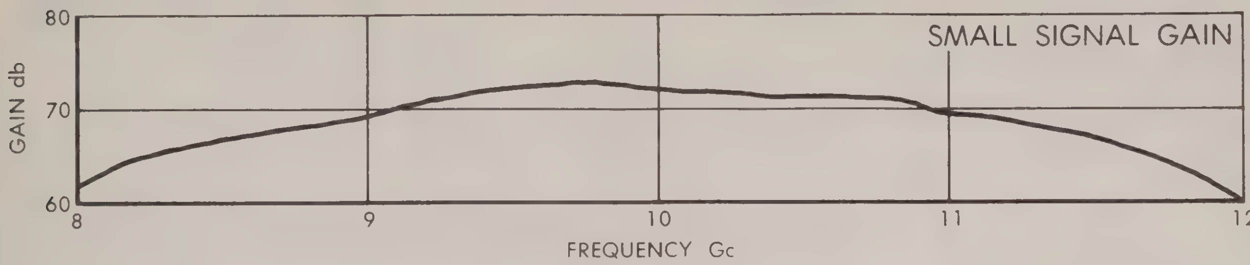
Temperature: –54°C to + 85°C

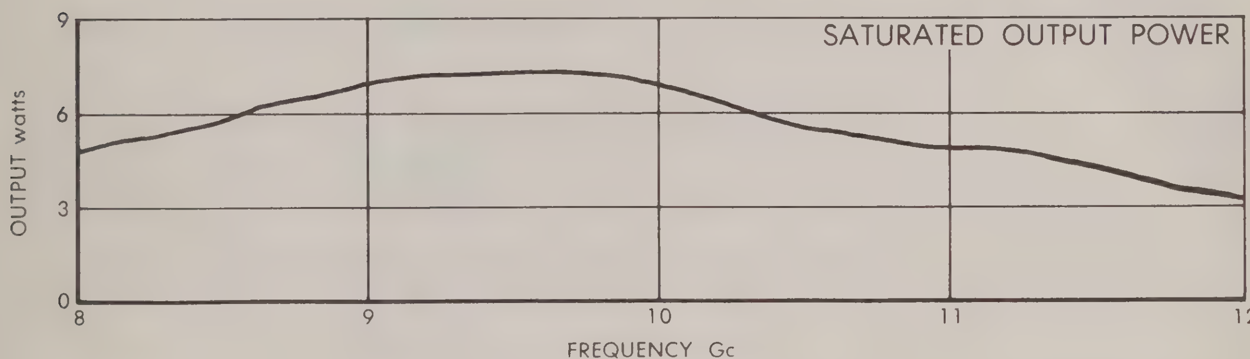
Altitude: 70,000 ft.

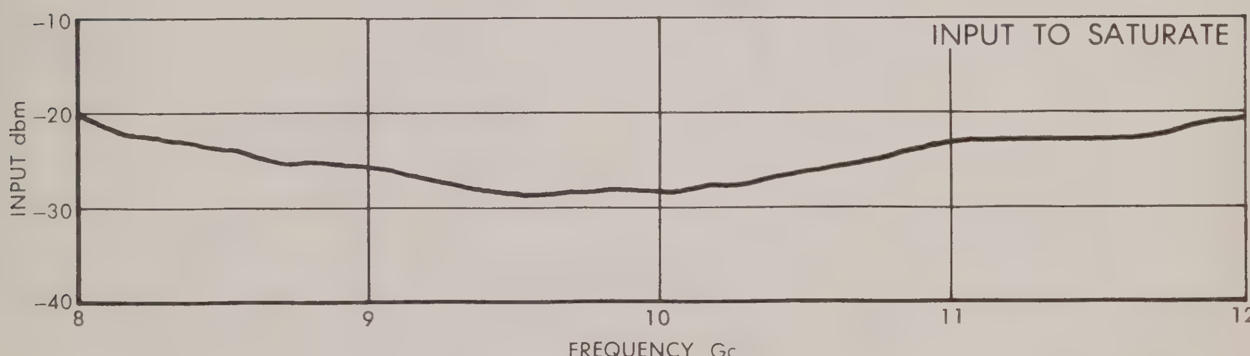
NOTE: This data should not be used for final equipment design.

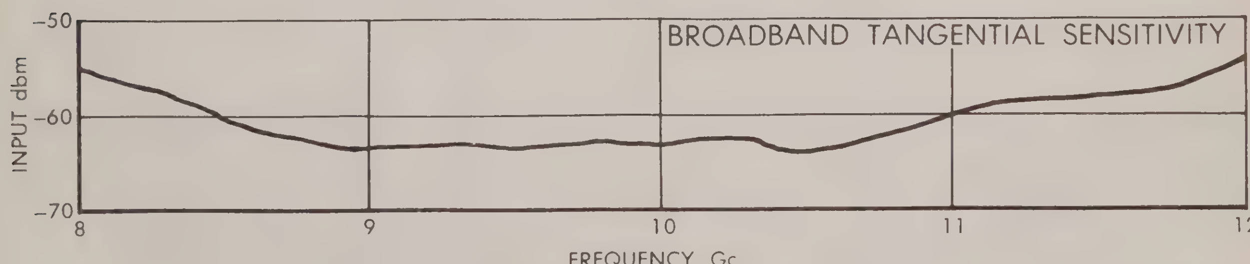
EM-1050 TYPICAL OPERATING CHARACTERISTICS

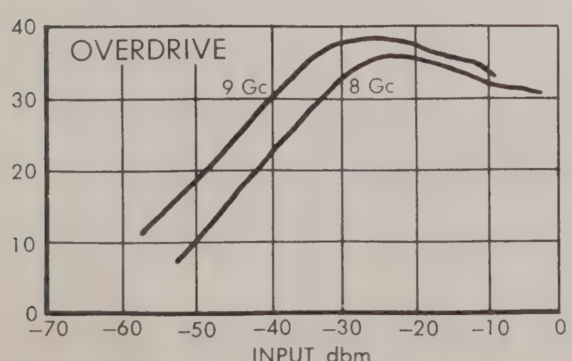
ANODE VOLTAGE	3300 Vdc	FOCUS VOLTAGE	−40 Vdc
CATHODE CURRENT	28 mAdc	FILAMENT VOLTAGE	6.3 Vac

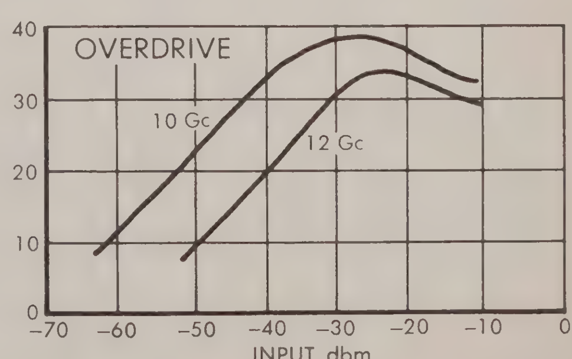








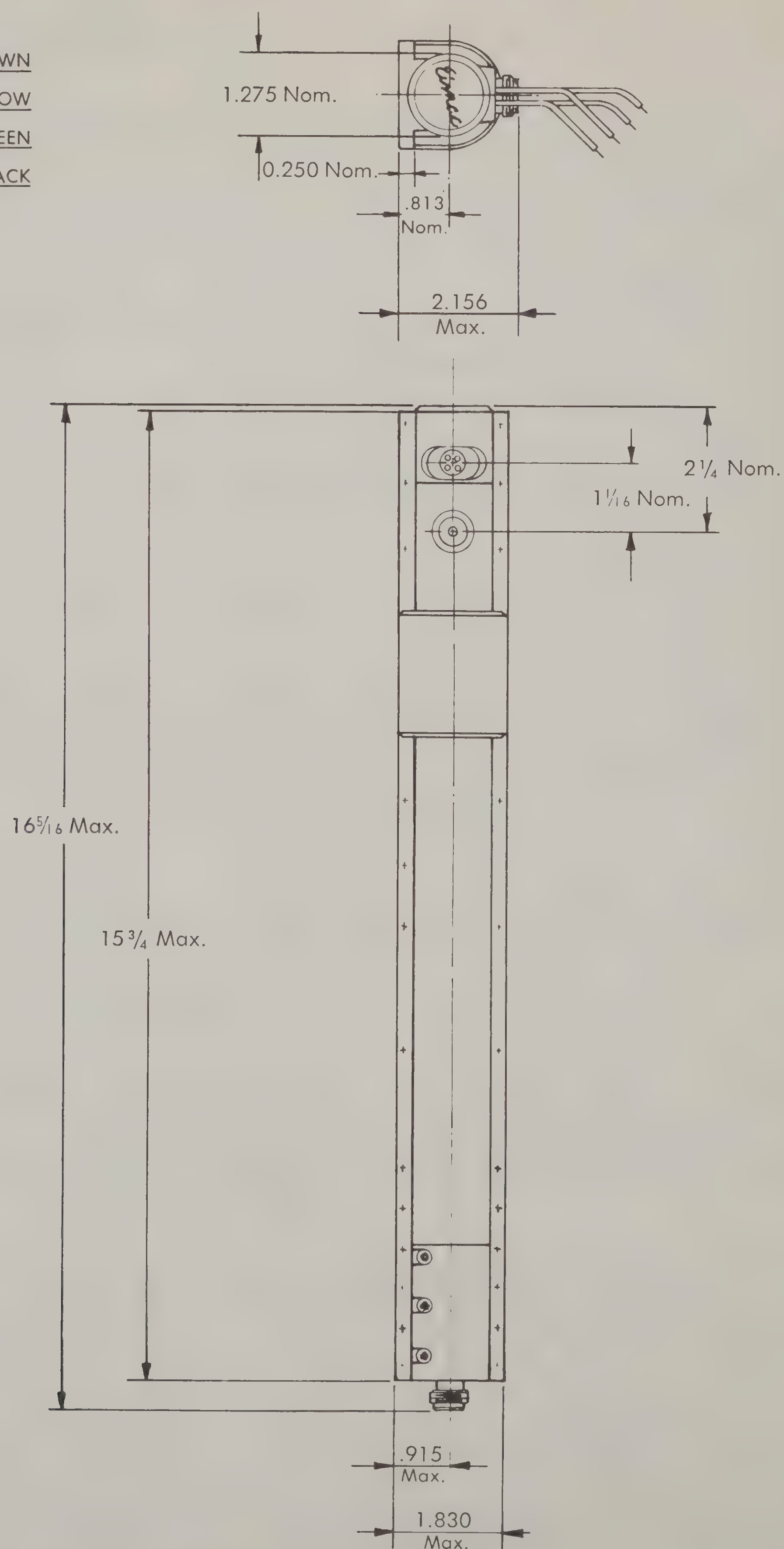




EM-1050

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-1051

TRAVELING WAVE TUBE

8.0 to 12.0 Gc.

3 Watts Min.

30 db Gain

TENTATIVE DATA FOR EIMAC EM-1051 TRAVELING WAVE TUBE

The Eimac EM-1051 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperatures. The EM-1051 utlizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 3 watts CW over the frequency range of 8.0 to 12.0 Gc with a nominal small signal gain of 30 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of +85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	8.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3500 VOLTS
D-C FOCUS ELECTRODE VOLTAGE* NEGATIVE WITH RESPECT TO CATHODE	50 VOLTS
D-C CATHODE CURRENT	30 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigacycles
Minimum Output Power	3.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	3300 volts
D-C Cathode Current	28 milliamperes
D-C Focus Electrode Voltage*	–40 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1051 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1051 conforms generally with MIL-E-5272C, "Environmental Testing, Areonautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

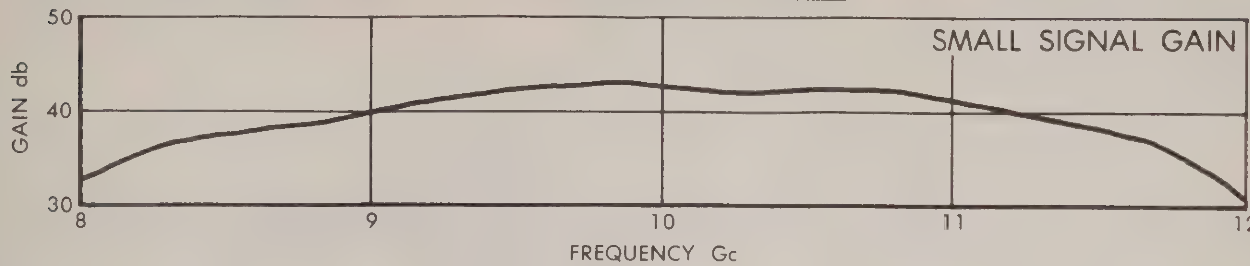
Temperature: –54°C to + 85°C

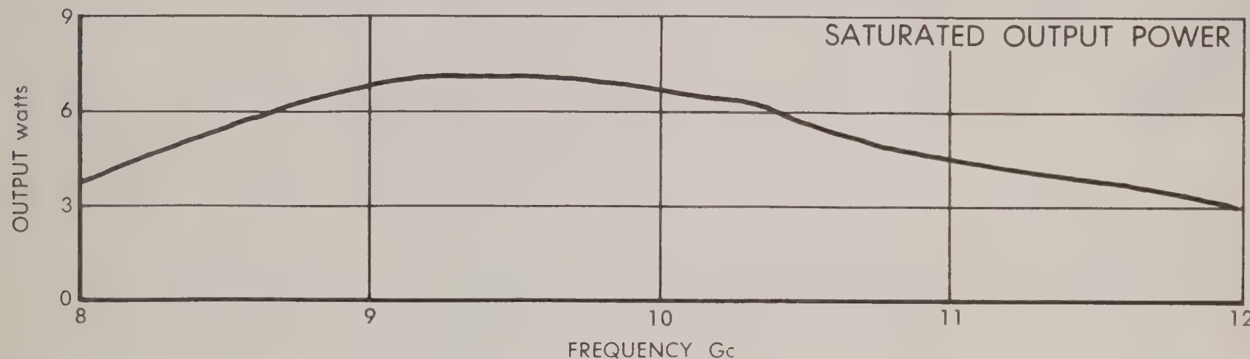
Altitude: 70,000 ft.

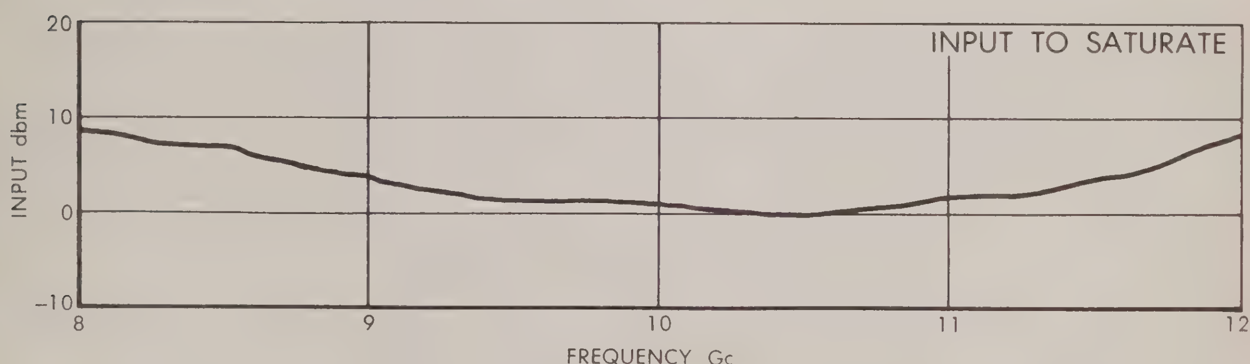
NOTE: This data should not be used for final equipment design.

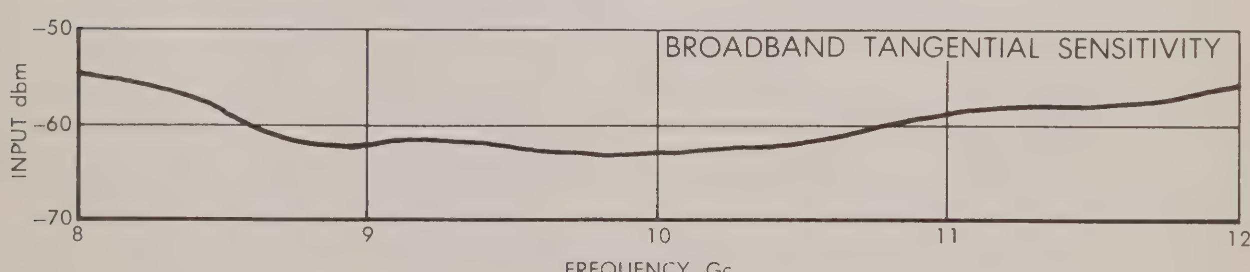
EM-1051 TYPICAL OPERATING CHARACTERISTICS

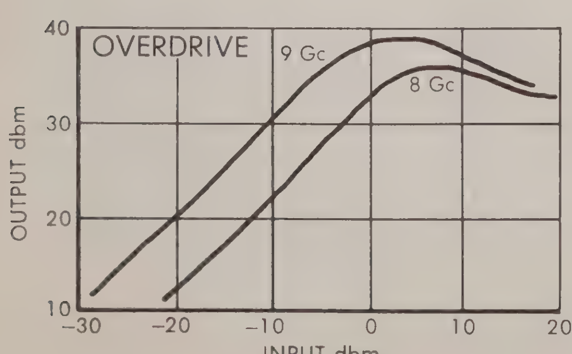
ANODE VOLTAGE 3300 Vdc
CATHODE CURRENT 28 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 Vac

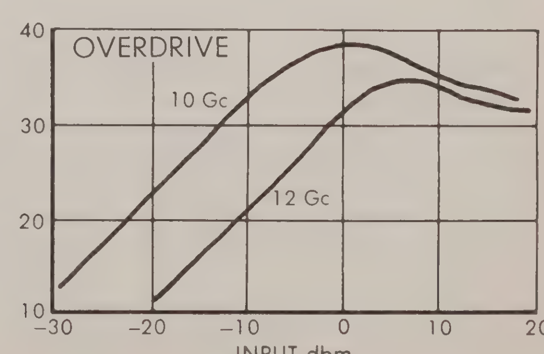








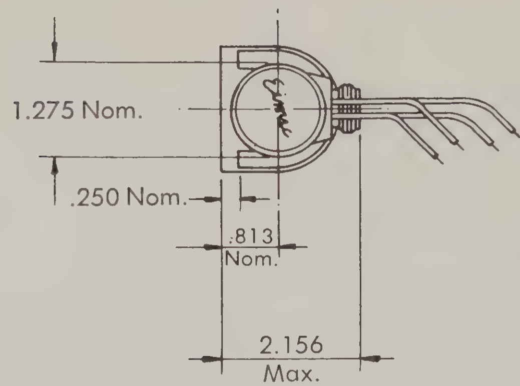


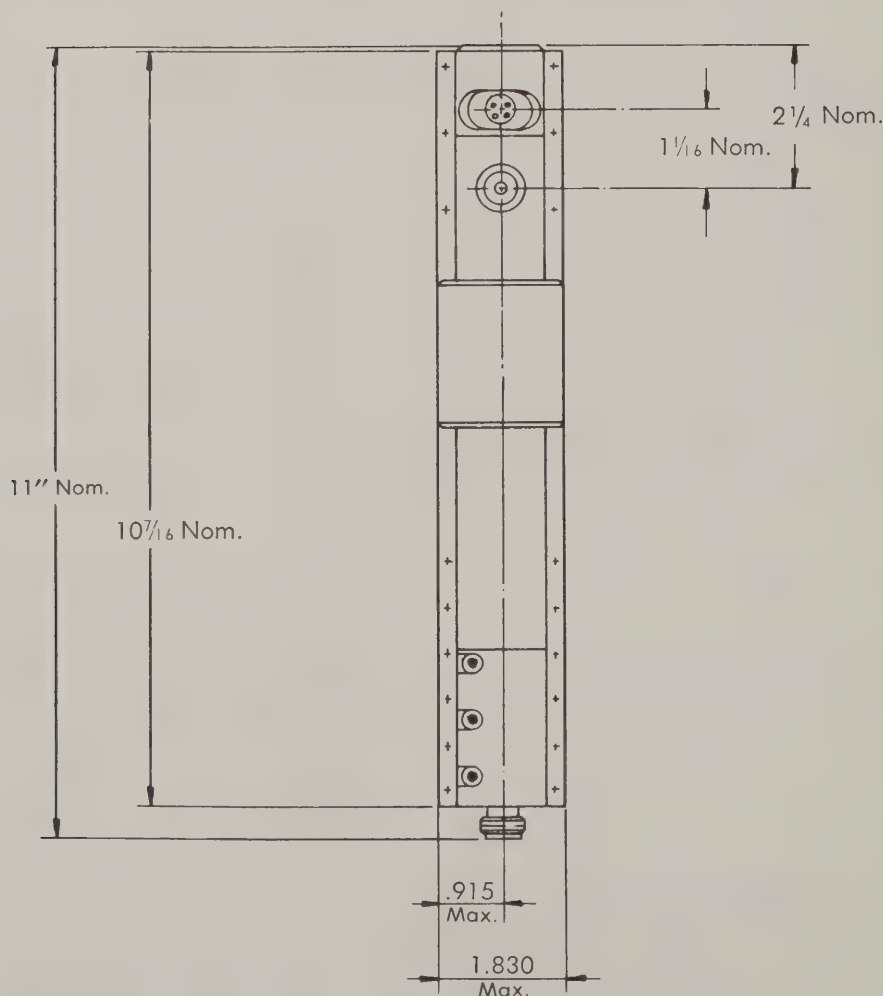


EM-1051

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

TENTATIVE DATA

EM-1060

TRAVELING WAVE TUBE

2.5 to 11.0 Gc.

½ Watt Min.

30 db Gain

TENTATIVE DATA FOR EIMAC EM-1060 TRAVELING WAVE TUBE

The Eimac EM-1060 is an S/C/X-band, ruggedized, light weight power amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperatures. The EM-1060 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of ½ watt and 30 db gain at 2.5 Gc, and at least 1 watt and 30 db gain throughout C and X bands.

The integral heat sink/mounting flange allows operation to ambient temperatures of + 85°C without additional cooling. Flexible leads provide electrical connections to the tube.

APPLICATIONS:

The extremely wide bandwidth of the EM-1060, coupled with its high gain and ability to perform under adverse environmental conditions, make it an excellent choice for radar augmentation or ECM applications in high performance aircraft or missile systems. In addition, the tube is ideally suited as a wideband, high power frequency amplifier for signal generator applications.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
TYPICAL Saturated Output Power	1 watt
Frequency Range	2.5 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	35 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	2.5 to 11.0 gigacycles
Minimum Output Power	0.5 watt
Small Signal Gain	30 decibels
D-C Beam Voltage*	2600 volts
D-C Cathode Current	32 milliamperes
D-C Focus Electrode Voltage*	–30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1060 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1060 conforms generally with MIL-E-5272C, "Environmental Testing, Areonautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

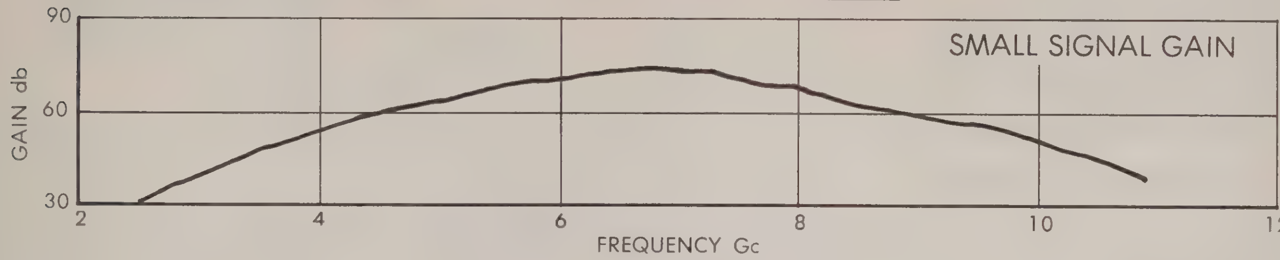
Temperature: –54°C to + 85°C

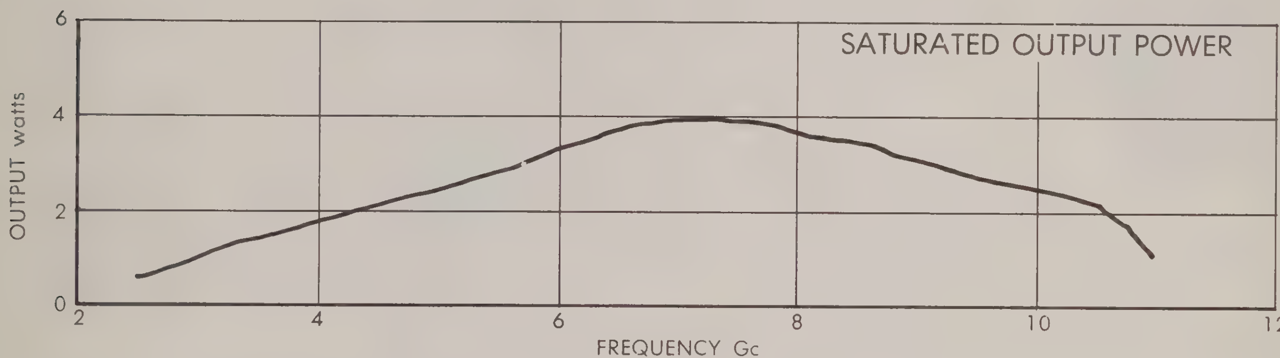
Altitude: 70,000 ft.

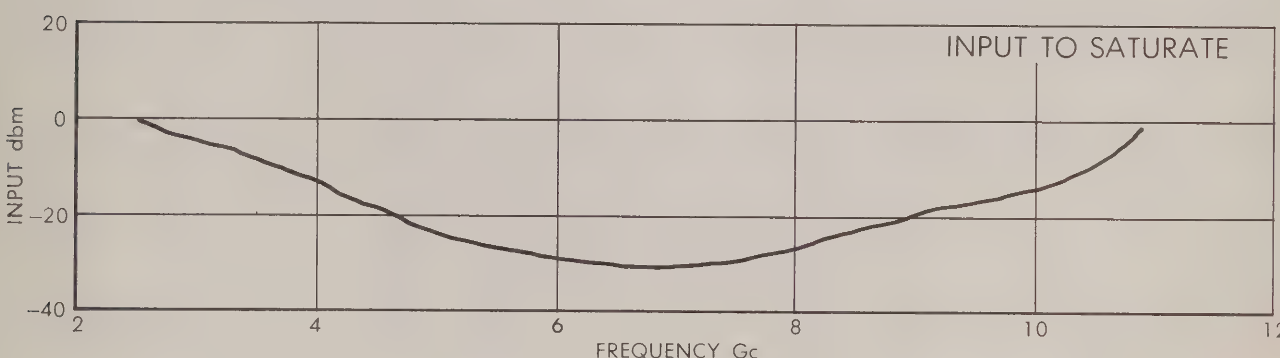
NOTE: This data should not be used for final equipment design.

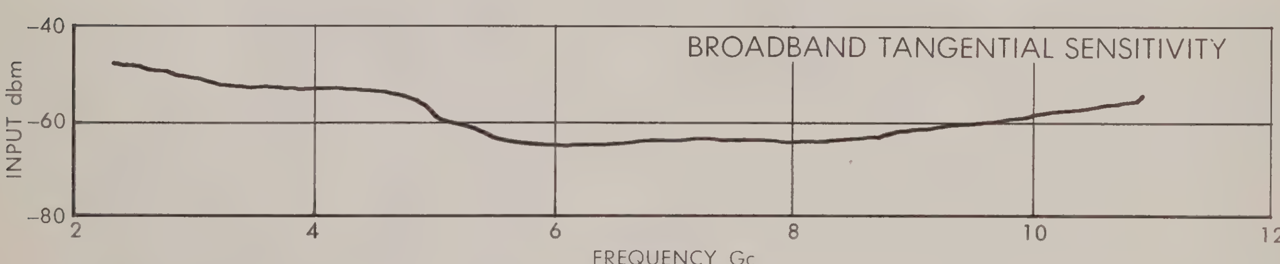
EM-1060 TYPICAL OPERATING CHARACTERISTICS

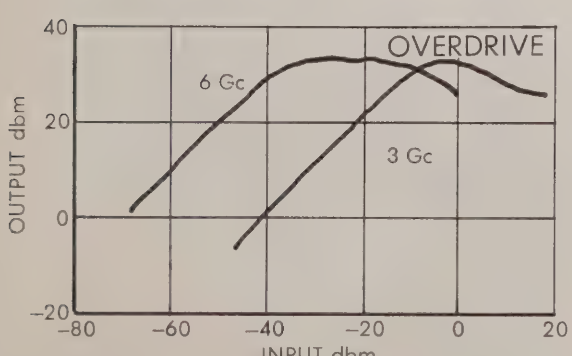
ANODE VOLTAGE	2600 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURENT	32 mAdc	FILAMENT VOLTAGE	6.3 Vac

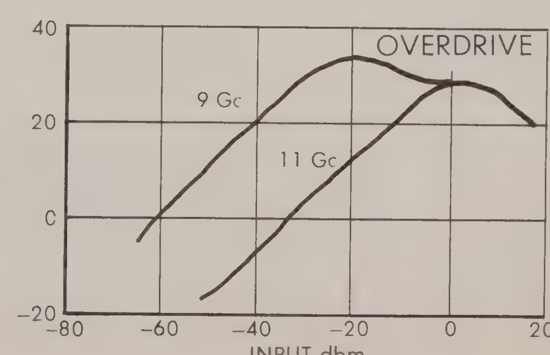








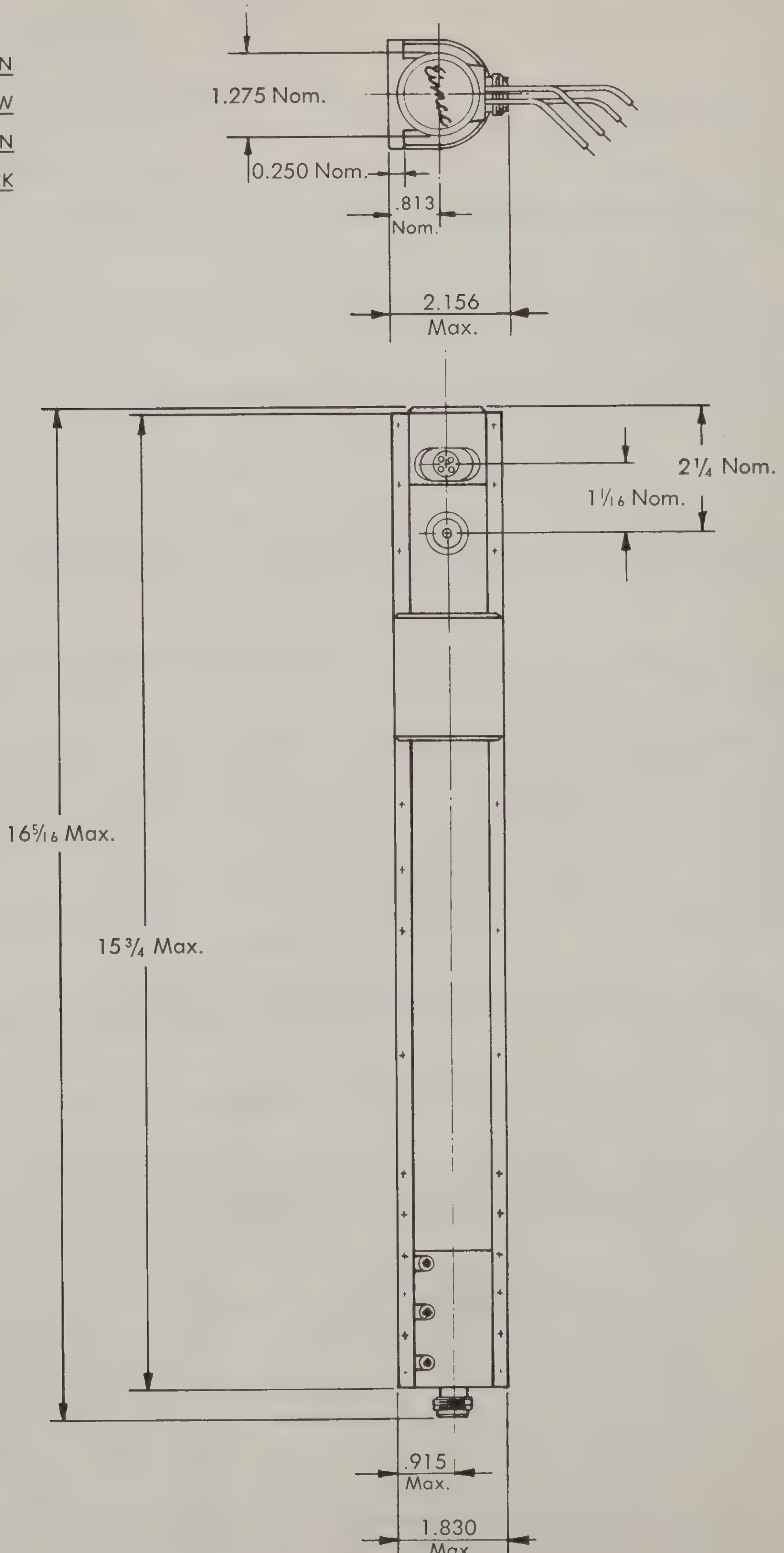




EM-1060

CONNECTIONS

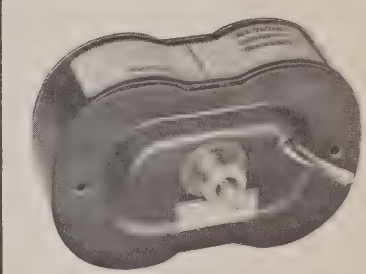
1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.

EM 747

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac EM 747 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 50 milliwatts into a 50-ohm termination over the frequency range of 450 to 1150 megacycles. On special order, this package can be matched to provide a minimum output power of 50 milliwatts over the complete bandwidth of 400 to 1200 megacycles.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators. In addition, the injection anode may be programmed to provide some leveling action on the output power during the frequency sweep.

The EM 747 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA		
	Warm-up time	60	seconds
Heater:	Voltage (AC or DC)	6.3	Volts
	Current	1.0	ampere
Minimum Output Power		50	milliwatts
Frequency Range		450 to 1150	megacycles

MECHANICAL

Operating Position	any
Cooling	Conduction
Electrical Connections	Flexible Leads
RF Output Coupling	Type N, Jack
Net Weight, including magnet and circuit	3.2 lbs.
Shipping Weight	10 lbs.
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	2 inches
Length	4 1/2 inches

MAXIMUM RATINGS

Anode Voltage*	2000	Volts
Cathode Current	20	Milliamperes
Injection Anode Voltage*	+500	Volts
Injection Anode Current	1	Milliampere

TYPICAL OPERATION (In EM 747 Circuit Assembly, Load VSWR = 1.15:1)

Frequency Range	450	1150	Megacycles
Anode Voltage* (Note 1)	800	1900	Volts
Cathode Current	2	8	Milliamperes
Typical Power Output	75	250	Milliwatts
Injection Anode FM Sensitivity	60	120	kc/volt
Injection Anode AM Sensitivity (Note 2)	-55	-65	Volts
Anode FM Sensitivity	.65		Mc/volt
Injection Anode Voltage	200		Volts
Injection Anode Current	0.5		Milliampere
Heater Voltage (AC)	6.3		Volts
Heater Current (AC)	0.8		Amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.
Note 2. The Injection Anode AM Sensitivity is defined as the change in voltage required to reduce the power by 3 db.

ANODE: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

CATHODE: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

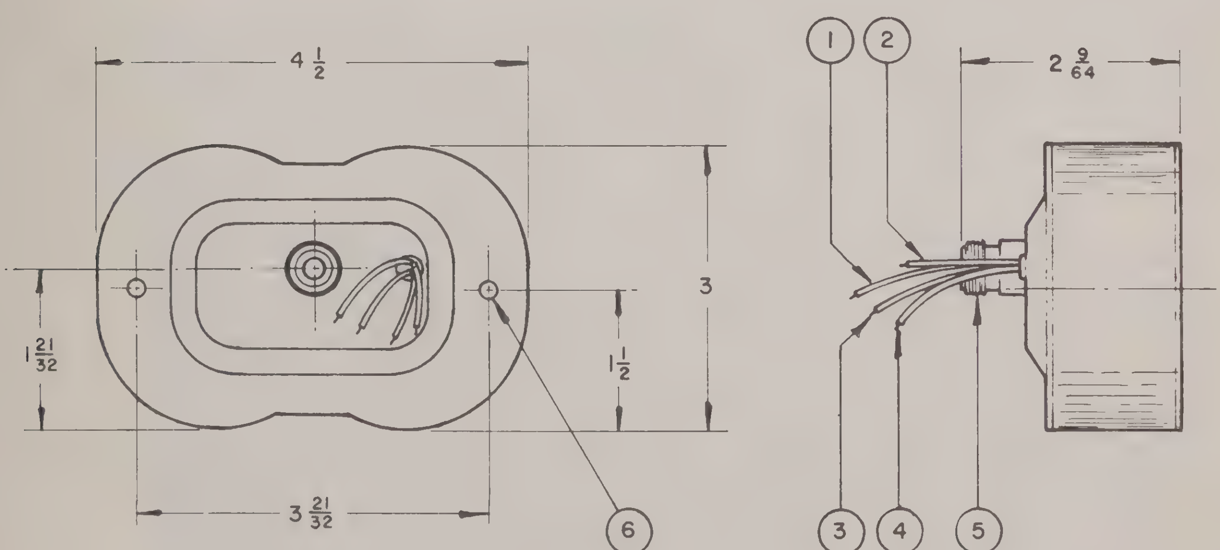
The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the EM 747 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

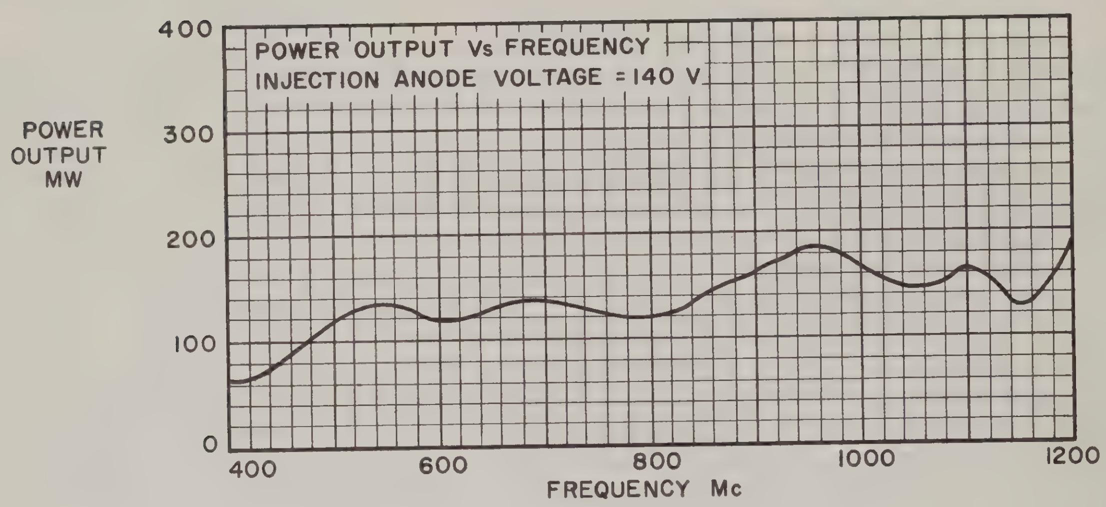
TEMPERATURE STABILITY: The permanent magnet for the EM 747 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM 747 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 500 megacycles, the temperature/frequency coefficient is typically 100 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency. On special order temperature compensation of .008% of operating frequency per degree Centigrade can be provided.

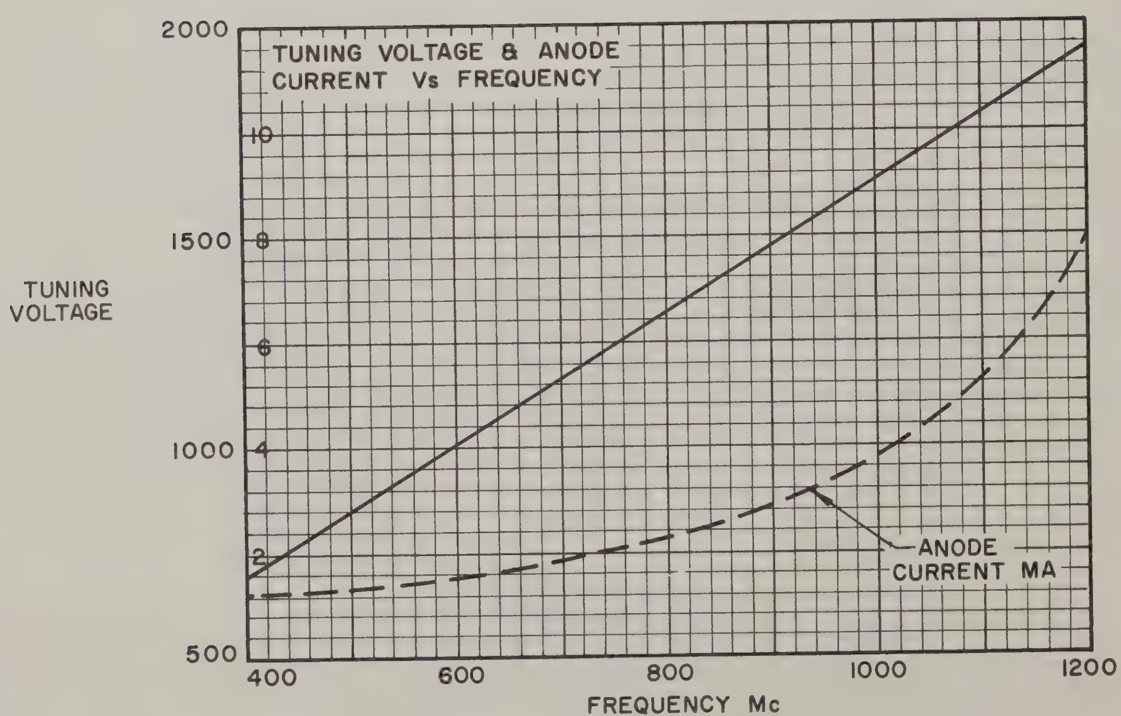
LINEARITY: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the EM 747 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3 - 5 parts per thousand over a 20 megacycle bandwidth.

SPECIAL APPLICATIONS: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.



6	3/16 DIA. MOUNTING HOLES (2) REQ'D
5	FEMALE TNC CONNECTOR
4	GROUND LEAD (GREEN)
3	HEATER LEAD (WHITE)
2	HEATER CATHODE LEAD (BLACK)
1	INJECTION ANODE LEAD (YELLOW)


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 140 V
POWER OUTPUT MW
400
300
200
100
0
400
600
800
1000
1200
FREQUENCY Mc


TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
TUNING VOLTAGE
2000
1500
1000
500
10
8
6
4
2
ANODE CURRENT MA
400
600
800
1000
1200
FREQUENCY Mc

Eimac

EITEL-McCULLOUGH, INC.

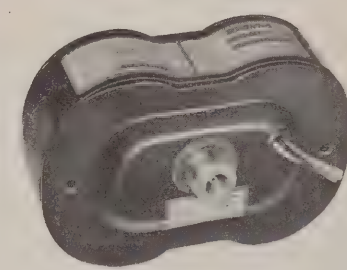
EM-1080

VOLTAGE TUNABLE MAGNETRON

FREQUENCY
1.2-2.2 kMc

MINIMUM OUTPUT POWER
100 mW

TYPICAL PERFORMANCE



S-BAND OSCILLATOR

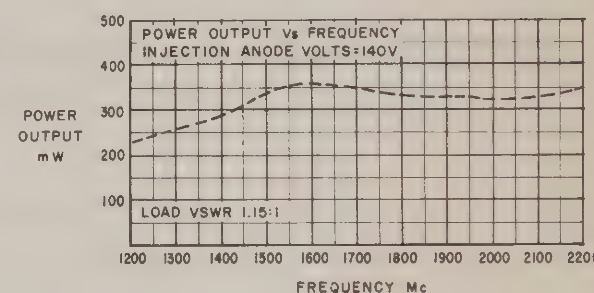
ELECTRICAL

Frequency Range	1.2-2.2 kMc
Anode Voltage	800-1400 V
Cathode Current	2-15 mA
Typical Output Power	140-300 mW
Anode FM Sensitivity	1.68 Mc/V
Injection Anode Voltage	200 V
Injection Anode Current	0.1 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	1500 V
Cathode Current	25 mA
Injection Anode Voltage	+700 V
Injection Anode Current	1 mA

* Damage to the tube may occur if maximum ratings are exceeded.

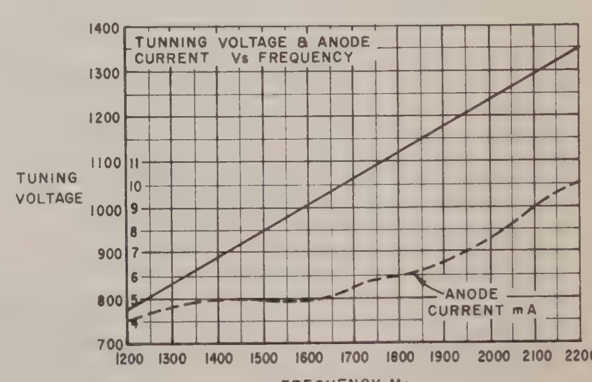


MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N. Jack
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.



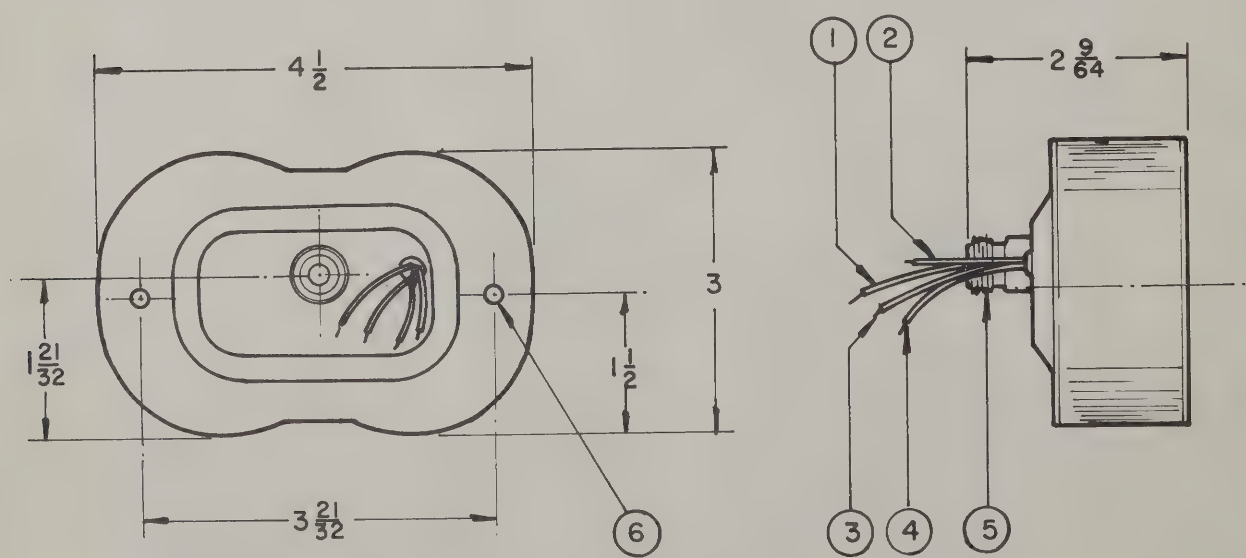
OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

(Effective 6-14-63 Edition 1)

APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.
3. TEMPERATURE STABILITY: The permanent magnet for the X-1080 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1080 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1500 megacycles, the temperature/frequency coefficient is typically 300 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.
4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



6	3/16 DIA. MOUNTING HOLES (2) REQ'D
5	FEMALE TYPE "N" CONNECTOR
4	GROUND LEAD (GREEN)
3	HEATER LEAD (WHITE)
2	HEATER CATHODE LEAD (BLACK)
1	INJECTION ANODE LEAD (YELLOW)

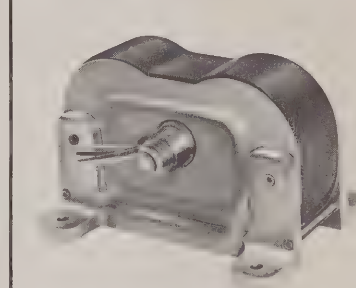
Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

TENTATIVE DATA

X-1081

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac X-1081 is a ruggedized, ceramic and metal, packaged voltage-tunable magnetron capable of delivering a minimum output power of 10 watts into a 50-ohm termination over the frequency range of 900-1200 megacycles.

Eimac's three terminal VTM circuit has been used in this tube to give a more uniform output circuit with the added advantage of one third more heat dissipating area extending out of the VTM envelope.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristing of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The X-1081 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA		
	Warm-up time	30	seconds
Heater:	Voltage (AC or DC)	6.3	volts
	Current	1.0	ampere
Minimum Output Power		10	watts
Frequency Range		900 to 1200	megacycles

MECHANICAL

Operating Position	any
Cooling	forced air
Electrical Connections	flexible leads
RF Output Coupling	Type N, or TNC female
Net Weight, including magnet and circuit:	3.2 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	3-3/8 inches
Length	4-1/2 inches

MAXIMUM RATINGS

Anode Voltage*	2400	volts
Cathode Current	30	milliamperes
Injection Anode Voltage*	800	volts
Injection Anode Current	1	milliampere

TYPICAL OPERATION (X-1081 Circuit Asssembly, Load VSWR = 1.15:1)

Frequency Range	900	1200	megacycles
Anode Voltage* (Note 1)	1800	2380	volts
Cathode Current	15	18	milliamperes
Typical Power Output	10	12	watts
Anode FM Sensitivity		.55	Mc/volt
Injection Anode Voltage		400	volts
Injection Anode Current		0.5	milliampere
Heater Voltage (AC)		6.3	volts
Heater Current (AC)		0.8	ampere

*All voltages referred to the cathode.
Note 1. The operating frequency is determined by the Anode Voltage.

APPLICATION

Cooling: To insure long life and best operation, sufficient cooling air is required to maintain the magnet temperature below 70° C.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1081 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

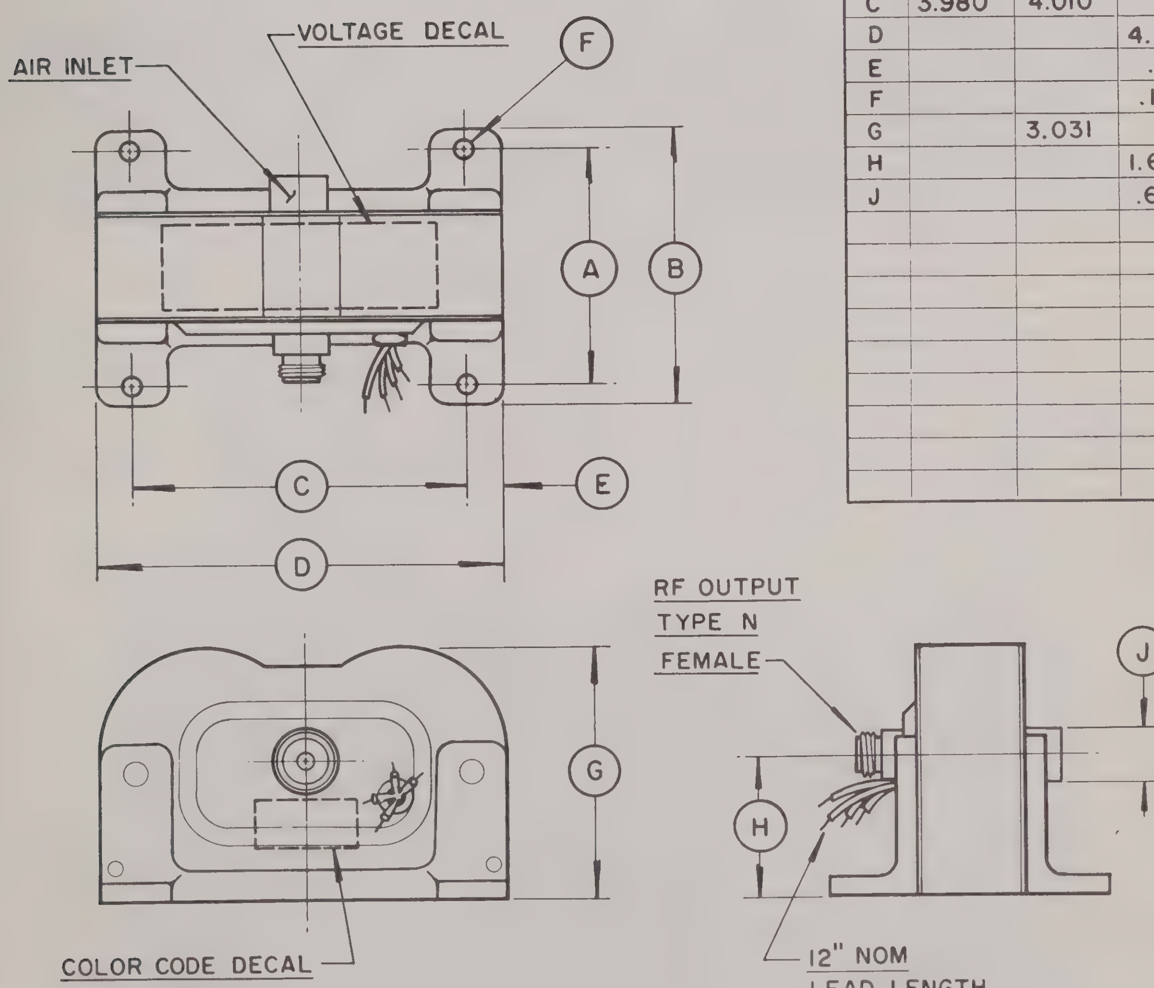
Temperature Stability: The permanent magnet for the X-1081 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1081 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tube. The frequency versus tuning voltage curve for the X-1081 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3-5 parts per thousand over a 20 megacycle bandwidth.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			2.875
B			3.375
C	3.980	4.010	
D			4.875
E			.437
F			.196 D.
G		3.031	
H			1.656
J			.680 D.



CONNECTIONS

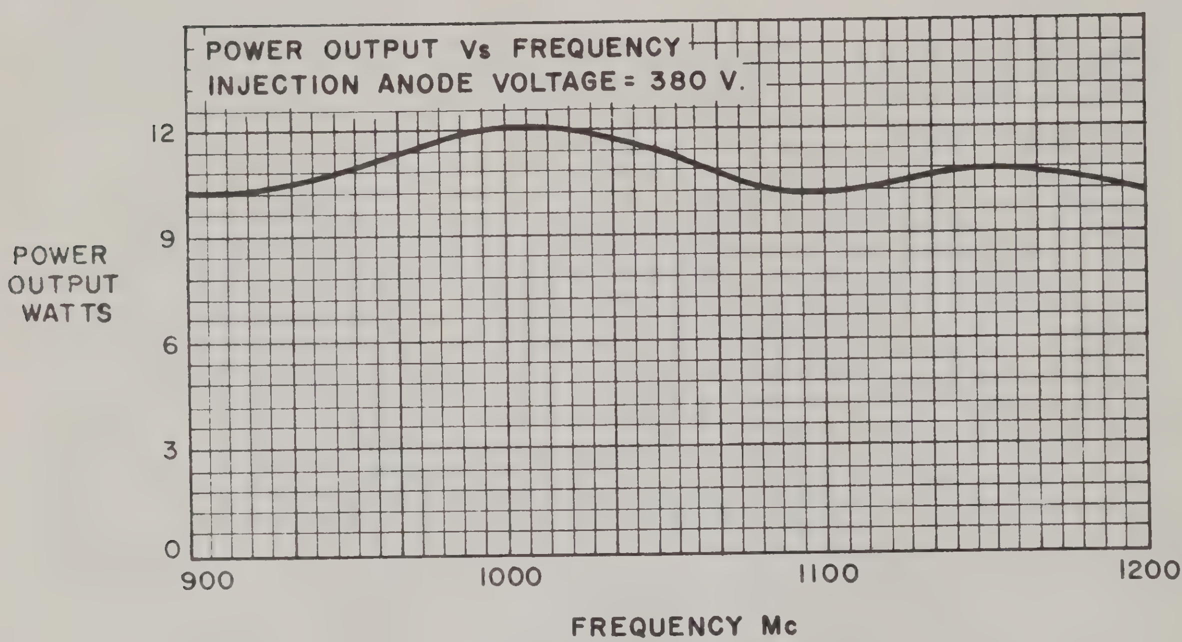
GROUND — GREEN

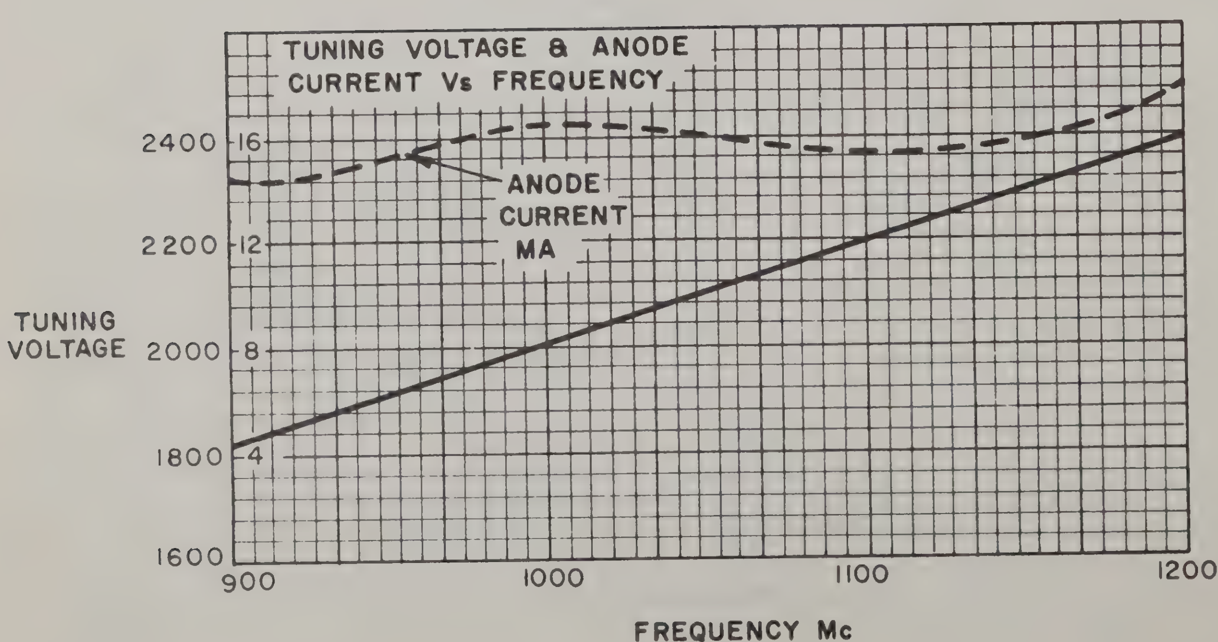
HEATER — WHITE

HEATER CATHODE — BLACK

INJECTION ANODE — YELLOW

X1081 VTM


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 380 V.
POWER
OUTPUT
WATTS
12
9
6
3
0
900
1000
1100
1200
FREQUENCY Mc


TUNING VOLTAGE & ANODE
CURRENT Vs FREQUENCY
ANODE
CURRENT
MA
TUNING
VOLTAGE
2400
2200
2000
1800
1600
16
12
8
4
900
1000
1100
1200
FREQUENCY Mc

Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X-1084

UHF
PACKAGED

VOLTAGE TUNABLE
MAGNETRON

The Eimac X-1084 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 30 milliwatts into a 50-ohm termination over the frequency range of 300 to 600 megacycles.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming and frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators. In addition, the injection anode may be programmed to provide some leveling action on the output power during the frequency sweep.

The X-1084 circuit assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA	
	Warm-up time	60 seconds
Heater:	Voltage (AC or DC)	6.3 volts
	Current	.8 ampere
Minimum Output Power		30 milliwatts
Frequency Range		300 to 600 megacycles

MECHANICAL

Operating Position	any
Cooling	conduction
Electrical Connections	flexible leads
RF Output Coupling	TNC Female
Net Weight, including magnet and circuit	3.2
Shipping Weight	10 lbs.
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	2 inches
Length	4½ inches

Effective 1 August 1962
Printed in U.S.A.

MAXIMUM RATINGS

Anode Voltage*	1800 volts
Cathode Current	10 milliamperes
Dissipation	18 watts
Injection Anode Voltage*	+500 volts
Injection Anode Current	.5 milliamperes

TYPICAL OPERATION (Load VSWR = 1.15:1)

Frequency Range	300	600 megacycles
Anode Voltage* (Note 1)	800	1550 volts
Cathode Current	1	3 milliamperes
Typical Power Output	50	200 milliwatts
Anode FM Sensitivity		.40 Mc/volt
Injection Anode Voltage		200 volts
Injection Anode Current		0.05 milliamperes
Heater Voltage (AC)		6.3 volts
Heater Current (AC)		0.8 amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and the injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

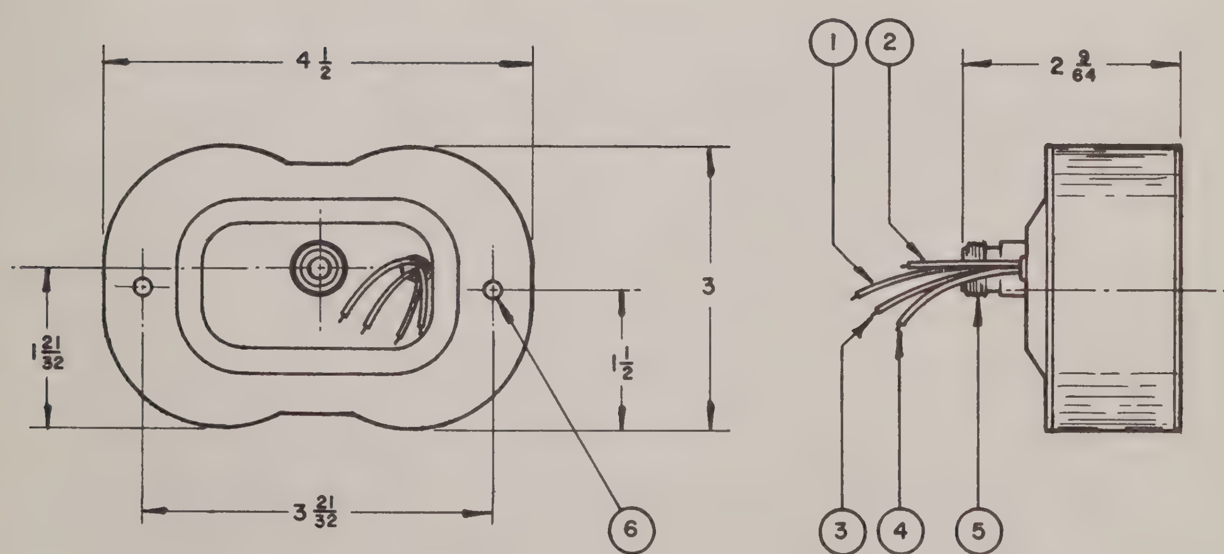
The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1084 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

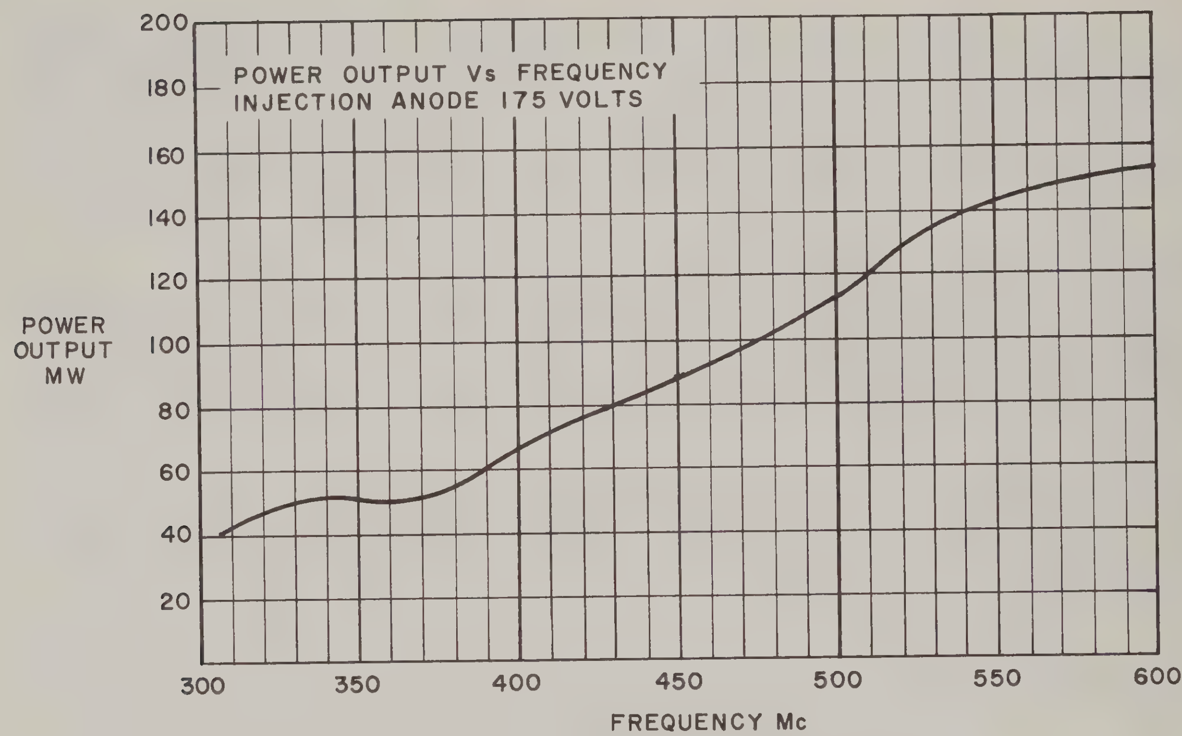
Temperature Stability: The permanent magnet for the X-1084 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1084 package is typically .008 of the operating frequency per degree Centigrade. Thus, for an operating frequency of 500 megacycles, the temperature/frequency coefficient is typically 40 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

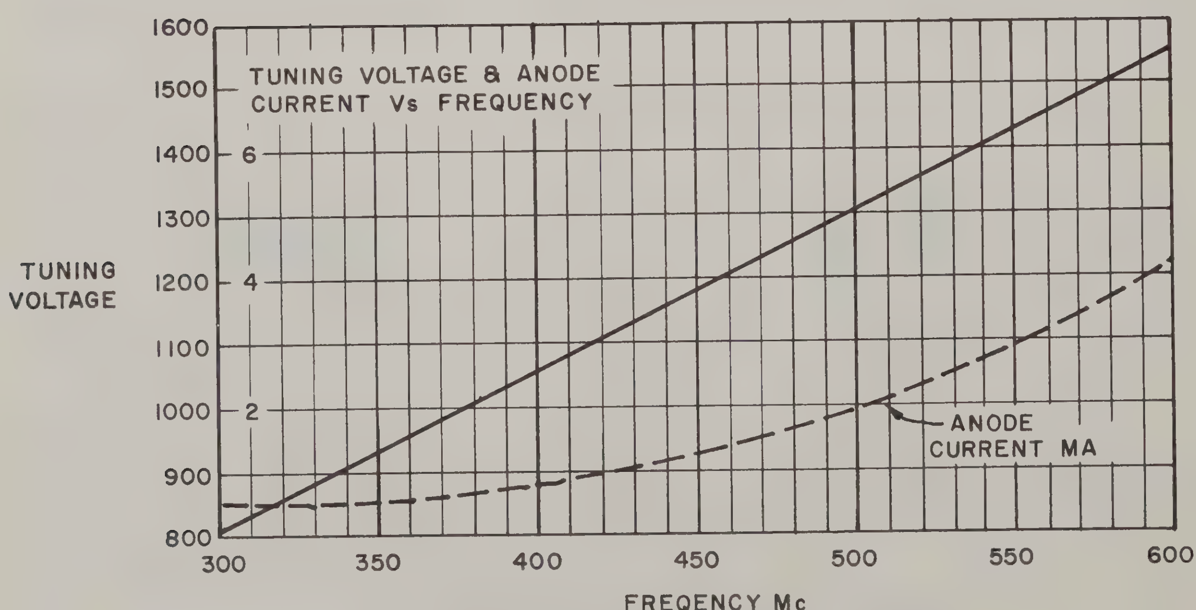
Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1084 is a straight line with a positive slope and maye be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3-5 parts per thousand over a 20 megacycle bandwidth.

Special Applications: For any aditional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.



6	3/16 DIA. MOUNTING HOLES (2) REQ'D
5	FEMALE TNC CONNECTOR
4	GROUND LEAD (GREEN)
3	HEATER LEAD (WHITE)
2	HEATER CATHODE LEAD (BLACK)
1	INJECTION ANODE LEAD (YELLOW)


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE 175 VOLTS
200
180
160
140
120
100
80
60
40
20
POWER
OUTPUT
MW
300
350
400
450
500
550
600
FREQUENCY Mc


TUNING VOLTAGE & ANODE
CURRENT Vs FREQUENCY
1600
1500
1400
1300
1200
1100
1000
900
800
6
4
2
TUNING
VOLTAGE
ANODE
CURRENT MA
300
350
400
450
500
550
600
FREQENCY Mc

Eimac®

EITEL-McCULLOUGH, INC.

OBJECTIVE DATA

X-1085

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON

OBJECTIVE DATA FOR EIMAC X-1085 VOLTAGE TUNABLE MAGNETRON

The Eimac X-1085 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 100 milliwatts into a 50-ohm termination over the frequency range of 1200 to 1400 megacycles.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators. In addition, the injection anode may be programmed to provide some leveling action on the output power during the frequency sweep.

The X-1085 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA	
	Warm-up time	60 seconds
Heater:	Voltage (AC or DC)	6.3 volts
	Current	0.8 ampere
Minimum Output Power		100 milliwatts
Frequency Range		1200 to 1400 megacycles

MECHANICAL

Operating Position	any
Cooling	conduction
Electrical Connections	Flexible Leads
RF Output Coupling	TNC Female
Net Weight, including magnet and circuit	2.0 lbs.
Shipping Weight	10 lbs.
Maximum Overall Dimensions (Magnet and Circuit):	
Height	2¼ inches
Width	2 7/64 Inches
Length	3⅞ inches

MAXIMUM RATINGS

Anode Voltage*	1500 Volts
Cathode Current	12 Milliamperes
Dissipation	18 Watts
Injection Anode Voltage*	+500 Volts

TYPICAL OPERATION (In X-1085 Circuit Assembly, Load VSWR = 1.15:1)

Frequency Range	1200	1400 Megacycles
Anode Voltage* (Note 1)	840	970 Volts
Cathode Current	2	8 Milliamperes
Typical Power Output	150	300 Milliwatts
Anode FM Sensitivity		1.5 Mc/volt
Injection Anode Voltage*		200 Volts
Injection Anode Current		.05 Milliampere
Heater Voltage (AC)		6.3 Volts
Heater Current (AC)		0.8 Ampere

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

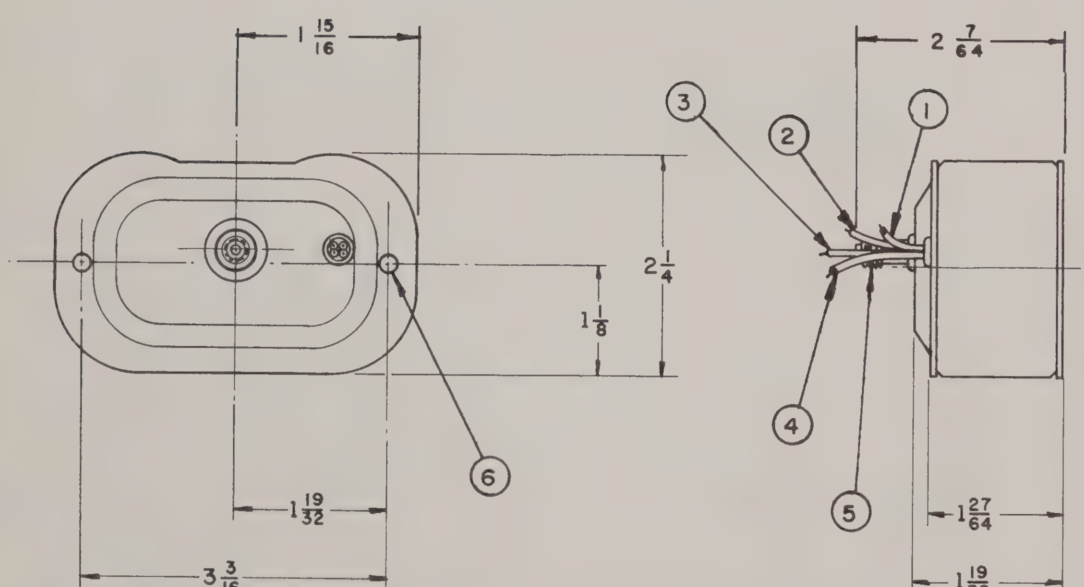
The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1085 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

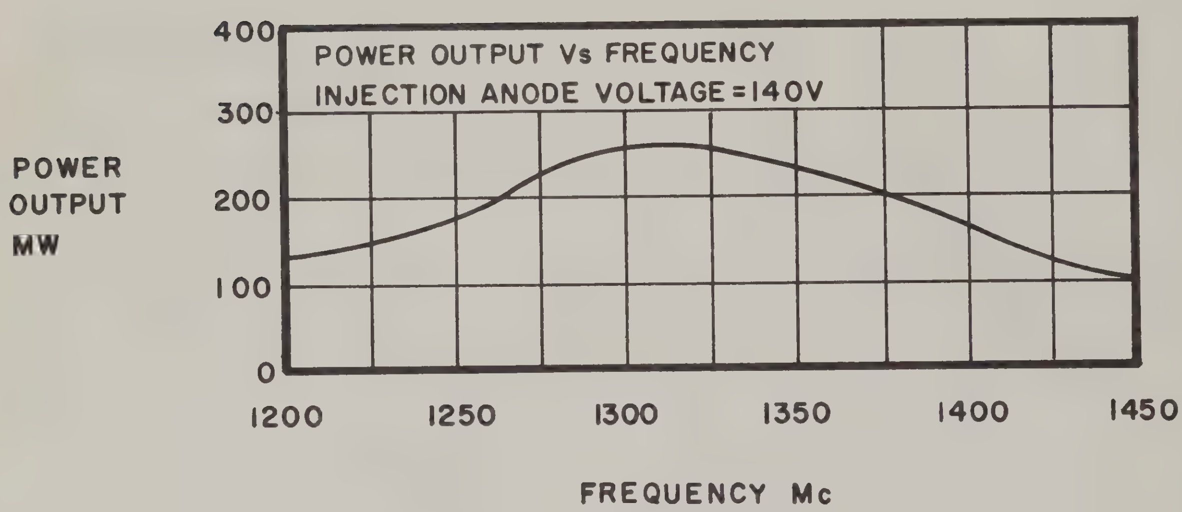
Temperature Stability: The permanent magnet for the X-1085 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1085 package is typically .008 of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1200 megacycles, the temperature/frequency coefficient is typically 100 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

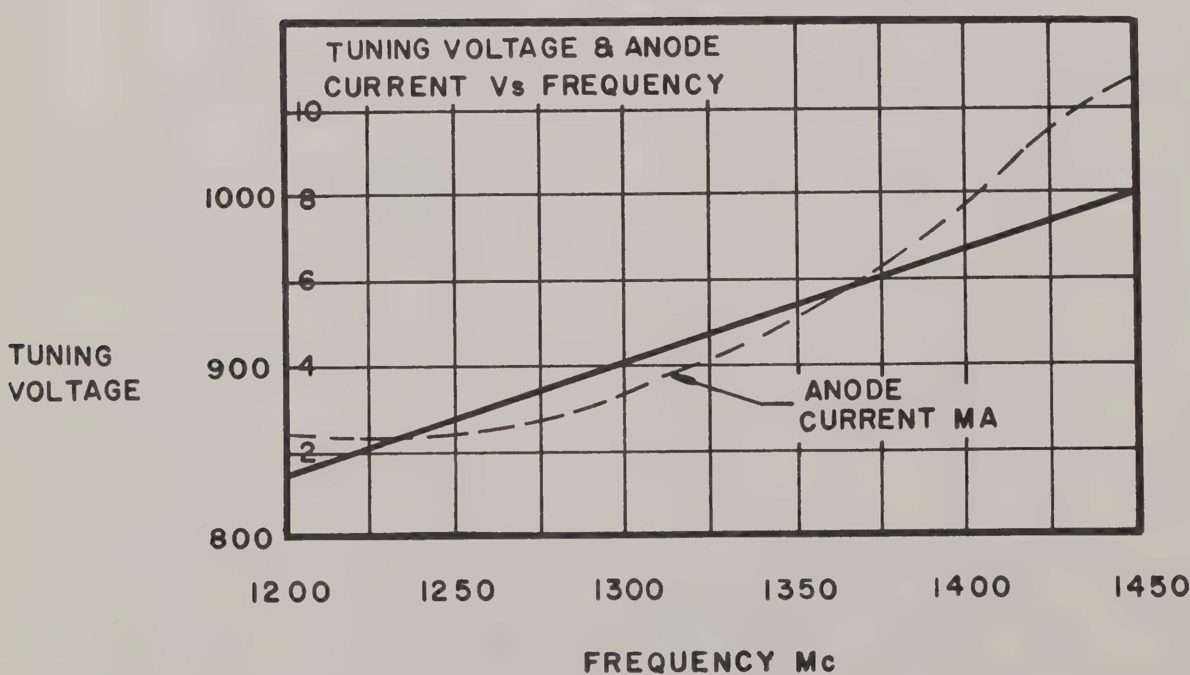
Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1085 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.



6	3/16 DIA. MOUNTING HOLES
5	RF CONNECTION, MATES W/MALE TNC
4	INJECTION ANODE LEAD-YELLOW
3	HEATER CATHODE LEAD-BLACK
2	HEATER LEAD—WHITE
1	GROUND LEAD—GREEN


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE=140V
POWER OUTPUT MW
400
300
200
100
0
1200
1250
1300
1350
1400
1450
FREQUENCY Mc


TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
TUNING VOLTAGE
1000
900
800
10
8
6
4
2
ANODE CURRENT MA
1200
1250
1300
1350
1400
1450
FREQUENCY Mc

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

EM-1086

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON

The Eimac EM-1086 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 15 watts into a 50 ohm termination over the frequency range of 940-1060 megacycles.

Eimac's three terminal VTM circuit has been used in this tube to give a more uniform output circuit with the added advantage of one-third more heat dissipating area extending out of the VTM envelope.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduced output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The linear tuning characteristics of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The EM-1086 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, EMA	
Warm-up Time	30 seconds
Heater: Voltage (AC or DC)	6.3 volts
Current	1.0 ampere
Minimum Output Power	15 watts
Frequency Range	940 to 1060 megacycles

MECHANICAL

Operating Position	any
Cooling	see note
Electrical Connections	flexible leads
RF Output Coupling	TNC male (6" flexible Rf connector)
Net Weight, including magnet and circuit	3.5 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	1.575 inches
Length	4.556 inches

MAXIMUM RATINGS

Anode Voltage*	2500 volts
Cathode Current	35 milliamperes
Injection Anode Voltage*	750 volts
Injection Anode Current	1 milliampere

TYPICAL OPERATION (EM-1086 Circuit Assembly, Load VSWR=1.15:1)

Frequency Range	940-1060	megacycles
Anode Voltage* (Note 1)	1840-2075	volts
Cathode Current	21 - 25	milliamperes
Typical Power Output	16 - 16	watts
Anode FM Sensitivity	.50	Mc/volt
Injection Anode Voltage	500	volts
Injection Anode Current	.02	milliamperes
Heater Voltage (AC)	6.3	volts
Heater Current (AC)	0.8	amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

APPLICATION

Cooling: To insure normal operation over prolonged periods, sufficient cooling is required so that the EM-1086 magnet temperature does not exceed 70°C.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential with the cathode and injection anode at appropriate negative potentials.

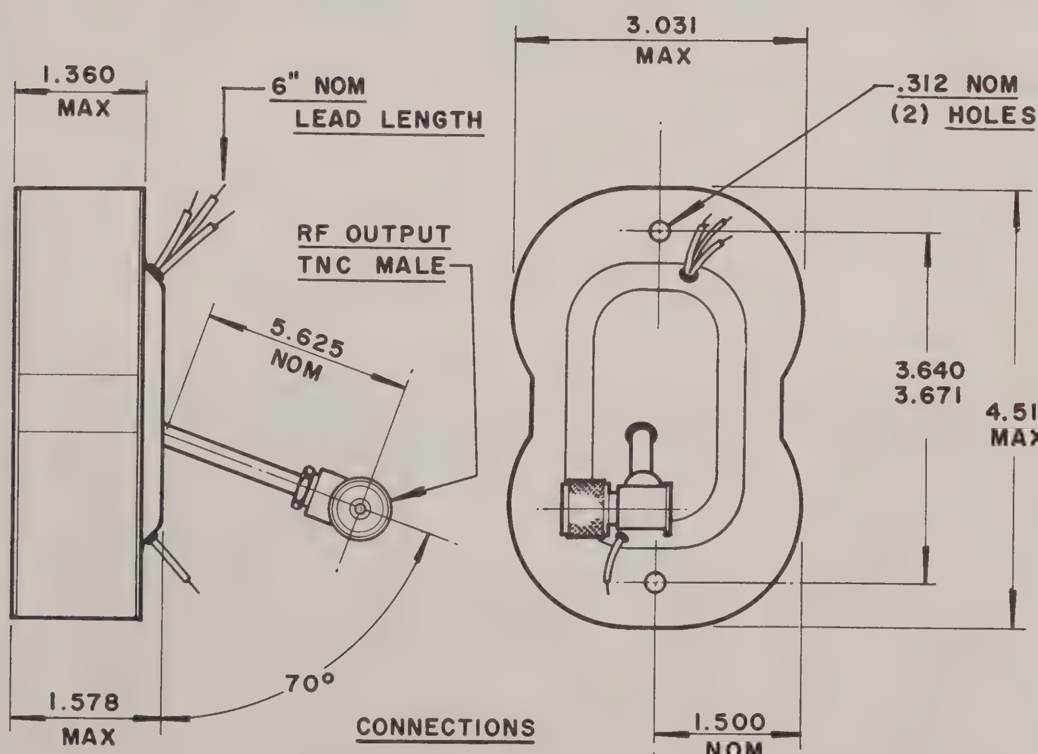
Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the EM-1086 heater in most applications as a result of the advanced counterwound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

Temperature Stability: The permanent magnet for the EM-1086 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM-1086 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1,000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451.
Cable: EIMAC.



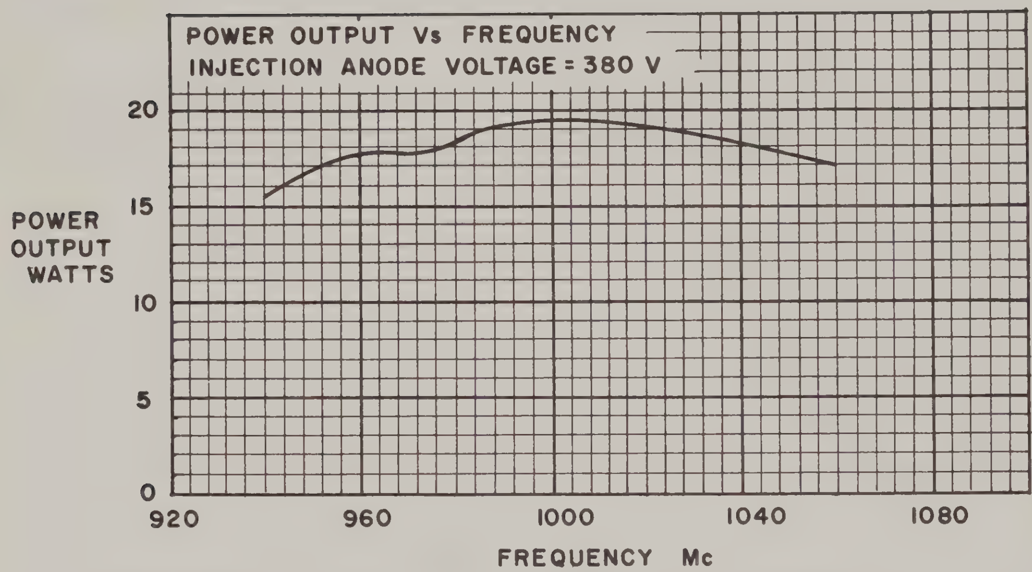
CONNECTIONS

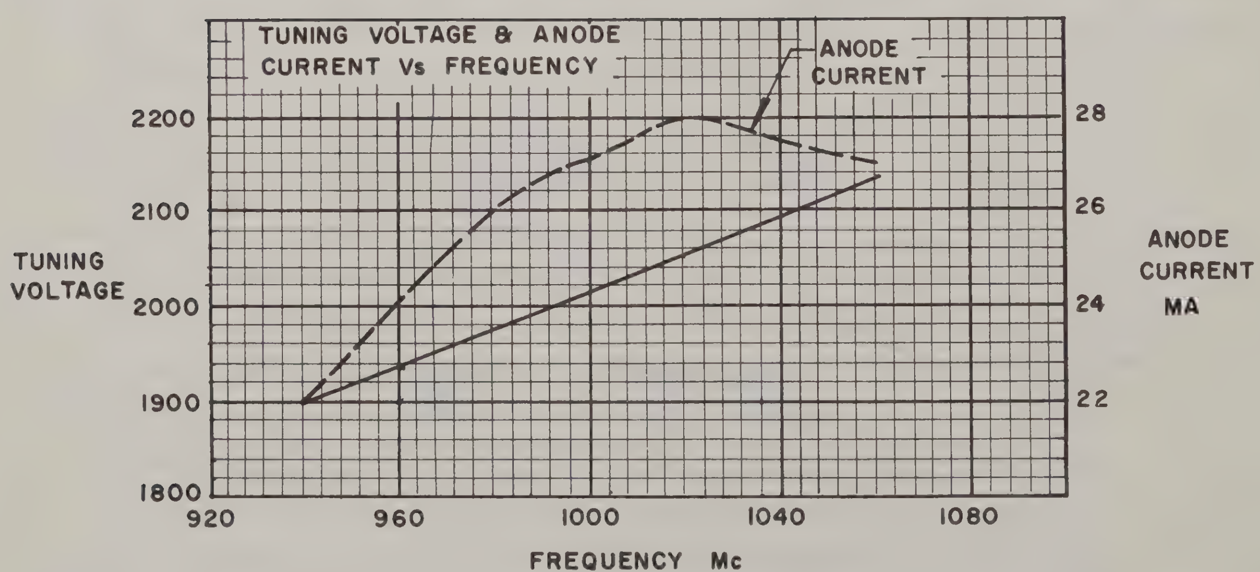
GROUND – BLACK

HEATER – BLUE

HEATER CATHODE – RED

INJECTION ANODE – WHITE


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 380 V
POWER OUTPUT WATTS
20
15
10
5
0
920
960
1000
1040
1080
FREQUENCY Mc


TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
ANODE CURRENT
TUNING VOLTAGE
2200
2100
2000
1900
1800
28
26
24
22
ANODE CURRENT MA
920
960
1000
1040
1080
FREQUENCY Mc

EITEL-McCULLOUGH, INC.

OBJECTIVE DATA

X-1091

S-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON

The Eimac X-1091 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 35 watts into a 50 ohm termination over the frequency range of 2.2 to 2.3 Kmc.

The electron injection design incorporated in this magentron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The X-1091 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, Matrix	
Warm-up Time	60 seconds
Heater: Voltage (AC or DC)	6.3 volts
Current	1.0 ampere
Minimum Output Power	35 watts
Frequency Range	2200 to 2300 megacycles

MECHANICAL

Operating Position	Any
Cooling	Forced Air
Electrical Connections	Flexible leads
RF Output Coupling	Type N or TNC Female
Net weight, including magnet and circuit	3.2 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	2 5/16 inches
Length	4 1/2 inches

MAXIMUM RATINGS

Anode Voltage*	2500 volts
Cathode Current	60 milliamperes
Injection Anode Voltage*	600 volts
Injection Anode Current	1 milliampere

TYPICAL OPERATION (In X-1091 Circuit Assembly, Load VSWR=1.15:1)

Frequency Range	2200-2300	megacycles
Anode Voltage* (Note 1)	1800-1940	volts
Cathode Current	35 - 40	milliamperes
Typical Power Output	35 - 35	watts
Anode FM Sensitivity	1.4	Mc/volt
Injection Anode Voltage	300	volts
Injection Anode Current	0.5	milliampere
Heater Voltage (AC)	6.3	volts
Heater Current	0.8	amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the anode voltage.

APPLICATION

Cooling: The X-1091 is designed to be cooled by forced air. To insure normal operation over long periods, sufficient cooling is required to maintain the magnet temperature below 70°C.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1091 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

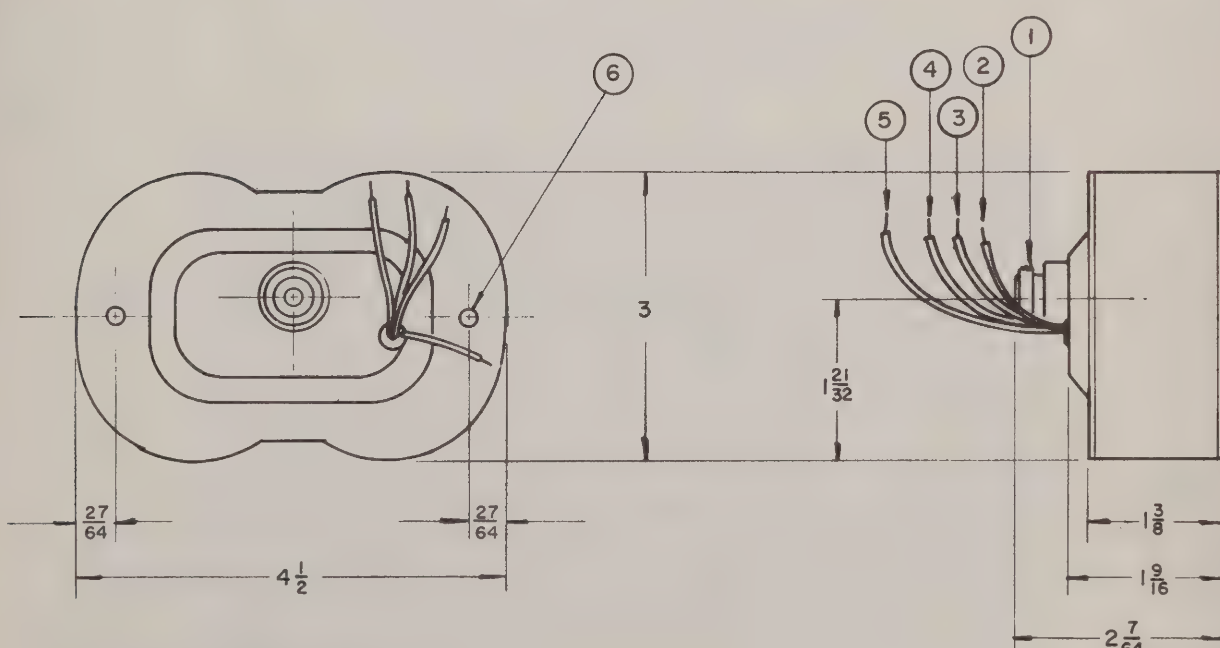
Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

Temperature Stability: The permanent magnet for the X-1091 has been temperature stabilized to minimize

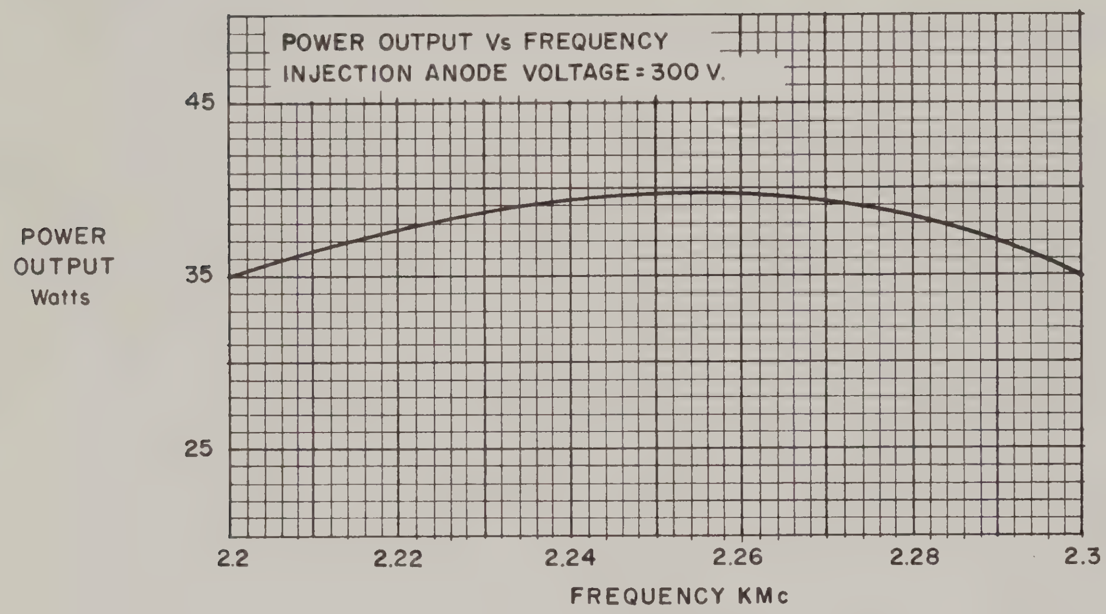
frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1091 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 2250 megacycles, the temperature/frequency coefficient is typically 180 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1091 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3-5 parts per thousand over a 20 megacycle bandwidth.

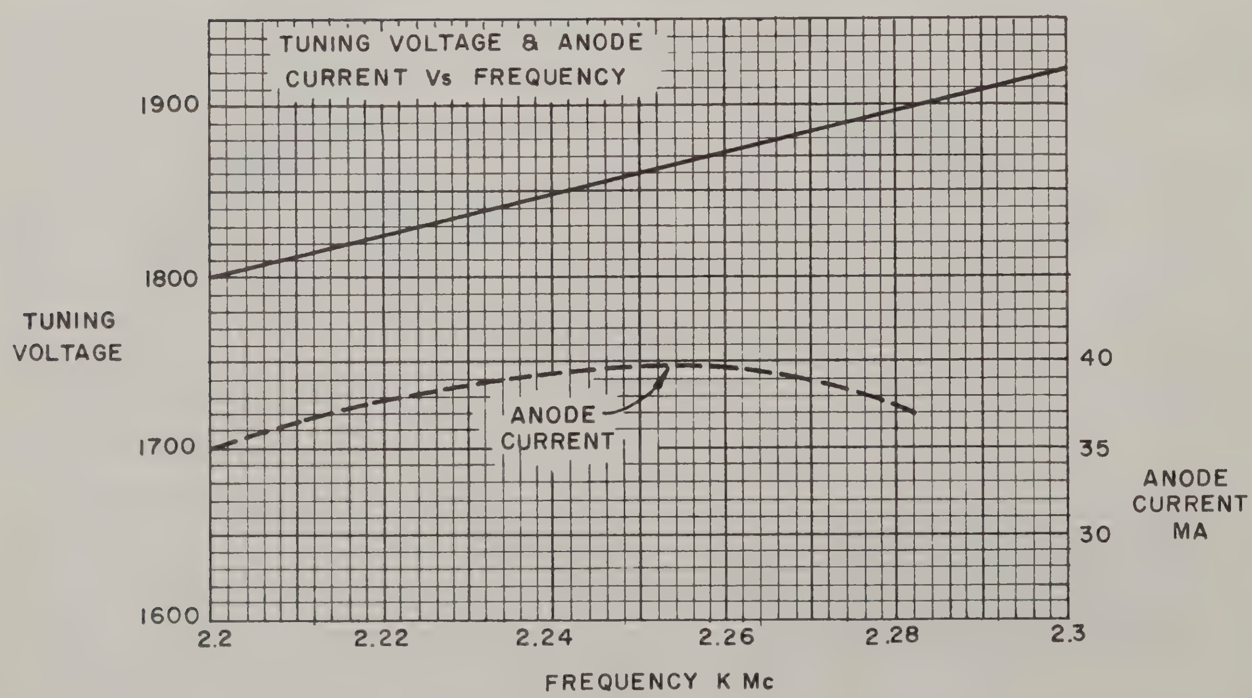
Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451.
Cable: EIMAC.



6	3/16 DIA. MOUNTING HOLES
5	GROUND LEAD – Green
4	HEATER LEAD – White
3	INJECTION ANODE LEAD – Yellow
2	HEATER CATHODE LEAD – Brown
1	FEMALE TNC CONNECTOR



POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 300 V.
POWER OUTPUT Watts
45
35
25
2.2
2.22
2.24
2.26
2.28
2.3
FREQUENCY KMc



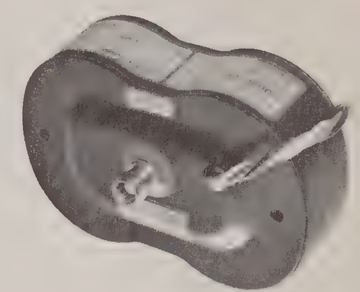
TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
TUNING VOLTAGE
1900
1800
1700
1600
ANODE CURRENT
40
35
30
ANODE CURRENT MA
2.2
2.22
2.24
2.26
2.28
2.3
FREQUENCY K Mc

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

OBJECTIVE DATA

X-1092

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac X-1092 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 750 milliwatts into a 50-ohm termination over the frequency range of 800 to 1450 megacycles.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The X-1092 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA		
	Warm-up time	60	seconds
Heater:	Voltage (AC or DC)	6.3	volts
	Current	0.8	ampere
Minimum Output Power		750	milliwatts
Frequency Range		800 to 1450	megacycles

MECHANICAL

Operating Position	any
Cooling	forced air
Electrical Connections	flexible leads
RF Output Coupling	TNC female
Net Weight, including magnet and circuit	3.5 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	2 inches
Length	4-1/2 inches

MAXIMUM RATINGS

Anode Voltage*	2500	volts
Cathode Current	25	milliamperes
Injection Anode Voltage*	+500	volts

TYPICAL OPERATION (In X-1092 Circuit Assembly, Load VSWR = 1.15:1)

Frequency Range	800	1450	megacycles
Anode Voltage* (Note 1)	1175	2070	volts
Cathode Current	7	15	milliamperes
Typical Power Output	0.9	3	watts
Anode FM Sensitivity		.75	Mc/volt
Injection Anode Voltage*		200	volts
Injection Anode Current		.05	milliampere
Heater Voltage (AC)		6.3	volts
Heater Current (AC)		0.8	ampere

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

APPLICATION

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1092 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

Cooling: To insure long life and best operation, the magnet temperature should not exceed 70° C.

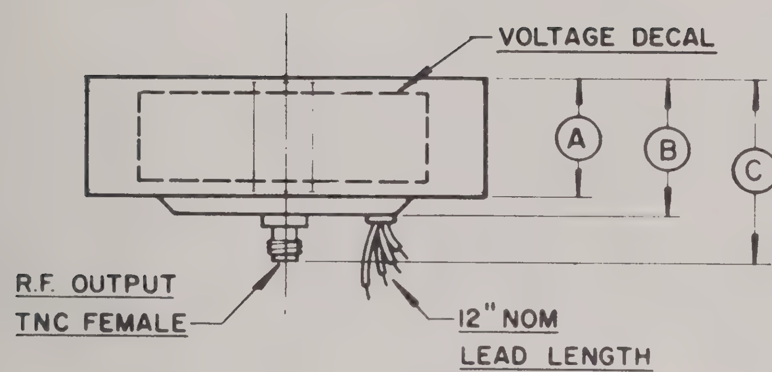
Temperature Stability: The permanent magnet for the X-1092 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1092 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

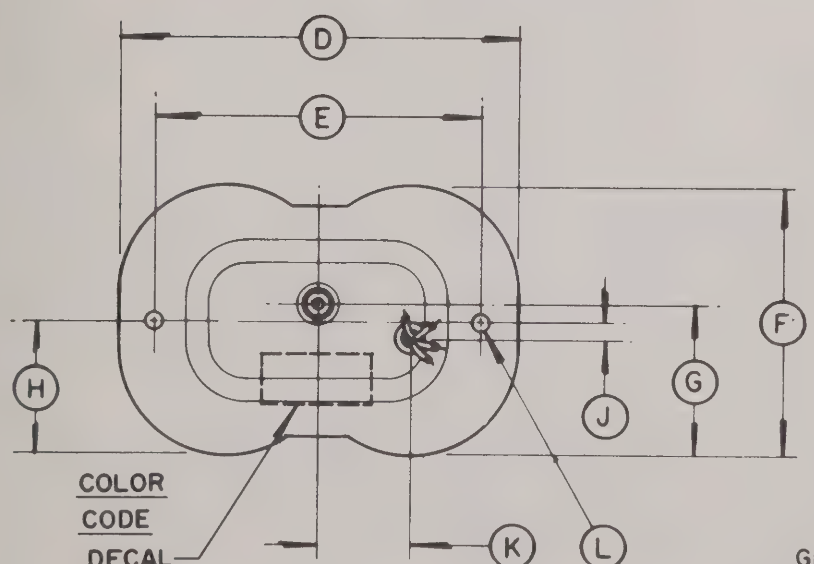
Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1092 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.





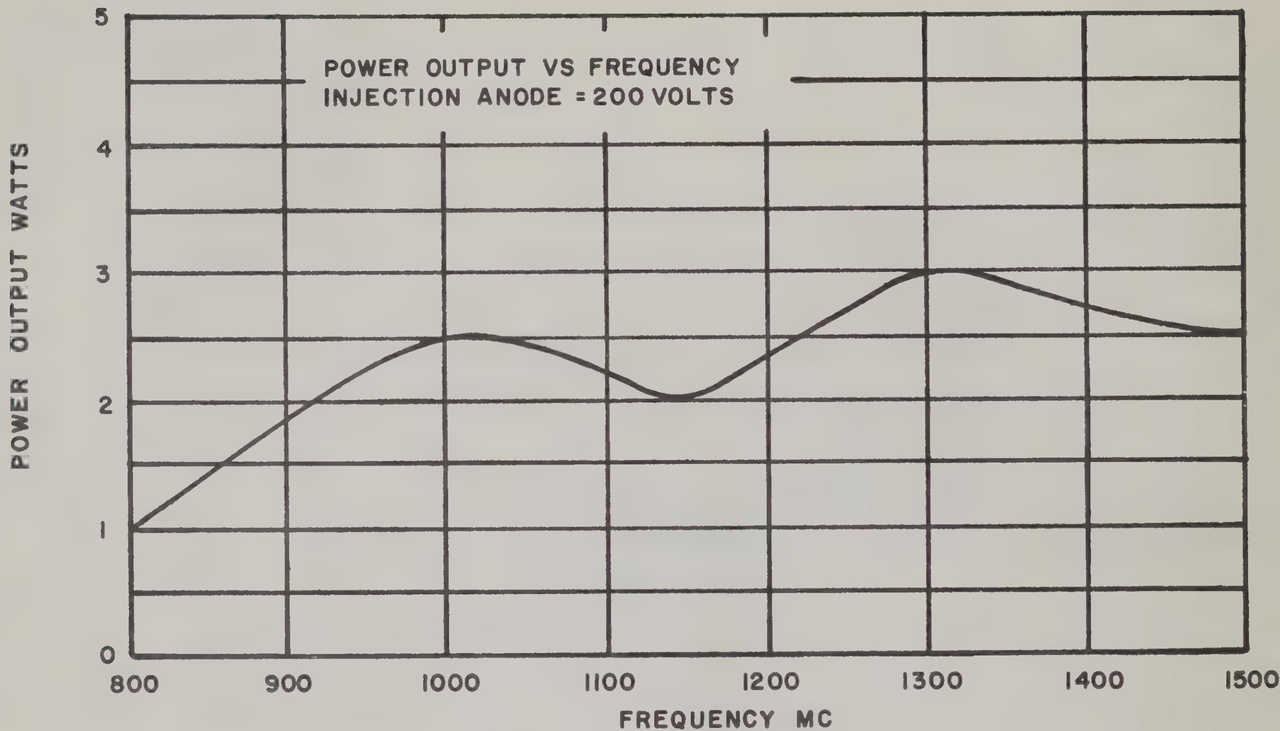
CONNECTIONS

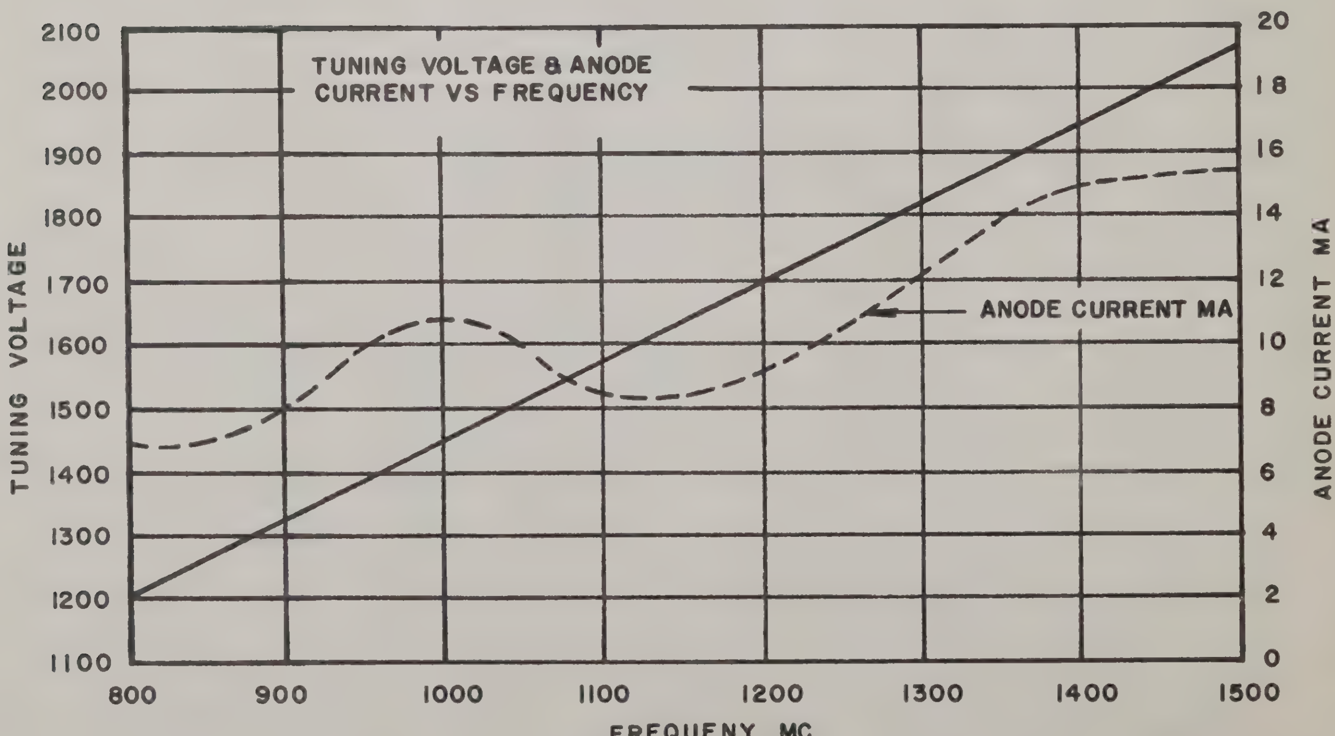
GROUND - GREEN

HEATER — WHITE

HEATER CATHODE — BLACK

INJECTION ANODE — YELLOW


POWER OUTPUT VS FREQUENCY
INJECTION ANODE = 200 VOLTS
POWER OUTPUT WATTS
0
1
2
3
4
5
800
900
1000
1100
1200
1300
1400
1500
FREQUENCY MC


TUNING VOLTAGE & ANODE
CURRENT VS FREQUENCY
ANODE CURRENT MA
TUNING VOLTAGE
ANODE CURRENT MA
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
0
2
4
6
8
10
12
14
16
18
20
800
900
1000
1100
1200
1300
1400
1500
FREQUENY MC

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

TABLE OF CONTENTS

VOLUME II

(1) These tubes, formerly manufactured by EIMAC Division of Varian, are now manufactured and marketed by the Varian Palo Alto Tube Division.

(2) These tubes, formerly manufactured by EIMAC Division of Varian, are now manufactured and marketed by the Varian Palo Alto TWT Division.

(3) These tubes, formerly manufactured by EIMAC Division of Varian, are now manufactured and marketed by the BOMAC Division of Varian.

FOR INFORMATION ON THESE AND OTHER VARIAN PRODUCTS CONTACT THE APPROPRIATE VARIAN DIVISION OR ANY VARIAN FIELD OFFICE. SEE OTHER SIDE OF THIS SHEET FOR A COMPLETE LIST OF VARIAN FIELD OFFICES.

*Divider Sheets Not Available

Effective Date 9-15-67

varian

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Palo Alto, Calif. 94303
TEL: (415) 326-4000
TWX: 415-492-9253

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Clearwater, Fla. 33516
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TWX: 810-866-0434

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Waltham, Mass. 02154
TEL: (617) 891-4560
TWX: 710-324-0688

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Park Ridge, Illinois 60068
TEL: (312) 825-6686
TWX: 910-253-1824

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TEL: (214) 235-2385
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Dayton, Ohio 45429
TEL: (513) 298-7318
TWX: 810-459-1924

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TEL: (213) 451-5877
TWX: 910-343-6868

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TEL: (315) 437-2568
TWX: 710-541-1524

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TWX: 710-832-9823

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TEL: 511-361

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Kamer 186
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CANADA
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TWX: 610-492-2641

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75 Paris 15e, France
TEL: 783-91-00

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Varian S.A.
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75 Paris 15e, France
TEL: 306-98-11

GERMANY
Varian GmbH
Breitwiesenstrasse 9
7 Stuttgart-Vaihingen
West Germany
TEL: (0711) 78 33 51

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Largo Turati, 49
Torino, Italy
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Varian AB
Skytteholmsvagen 7d
Solna (Stockholm), Sweden
TEL: (08) 82 00 30

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Baarerstrasse 77
6300 Zug, Switzerland
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UNITED KINGDOM AND IRELAND
Varian Associates, Ltd.
Russell House, Molesey Road
Walton-on-Thames
Surrey, England
TEL: Walton-on-Thames 2 87 66

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Palo Alto, Calif. 94304
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TWX: 910-373-1731

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LEL DIVISION
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Copiague, L.I., N.Y. 11726
TEL: (516) 264-2200
TWX: 510-224-6692

NATIONAL ELECTRONICS, INC.
A Varian Subsidiary
Geneva, Illinois 60134
TEL: (312) 232-4300
TWX: 910-237-1685

PALO ALTO TUBE DIVISION
611 Hansen Way
Palo Alto, Calif. 94303
TEL: (415) 326-4000
TWX: 910-373-1731

S-F-D LABORATORIES, INC.
A Varian Subsidiary
800 Rahway Avenue
Union, New Jersey 07083
TEL: (201) 687-0250
TWX: 710-985-4708

VARIAN ASSOCIATES OF CANADA, LTD.
45 River Road
Georgetown, Ontario, Canada
TEL: (416) 877-6901
TWX: 610-492-2641

4K200LX

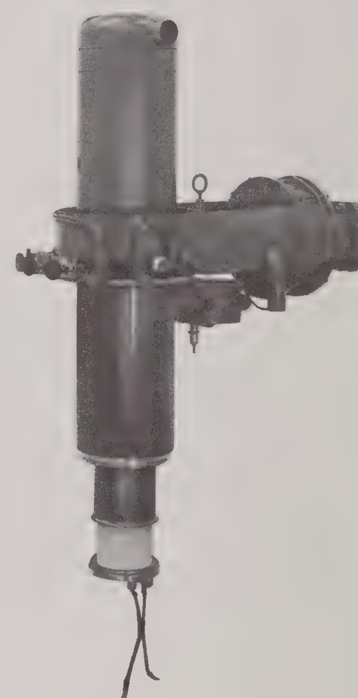
60 KW CW POWER AMPLIFIER L-BAND KLYSTRON

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

The 4K200LX is a CW amplifier klystron capable of producing an output power of 60 kW at frequencies from 1.235 to 1.365 GHz. Minimum power gain is 34 decibels.

Four integral cavities are used in the 4K200LX. Both input and output rf couplings are fixed. A built-in VacIon* pump is supplied which not only maintains a low gas pressure, but also provides a continuous indication of this pressure during operation.

A focusing electromagnet, Type Number H-204, has been designed for use with the 4K200LX.



CHARACTERISTICS

ELECTRICAL

Heater:	Voltage (±5%)	10	Vac
	Current (nominal)	26	Aac
Cathode:	Unipotential		
	Heating Time	5	Min
Power Gain		34	db
Output Power		60	kW
Frequency		1.235 - 1.365	GHz
VacIon*	Power Supply		
	Voltage	3.5	kVdc
	Current	300	μAdc

MECHANICAL

Operating Position	Vertical, collector up
Input rf Coupling	Type N Coaxial Fitting
Output rf Coupling	UG417A/U Flange

* Trademark

Printed in U.S.A.

MECHANICAL (Continued)

Cooling: Forced Air and Water	Flow Rate	Pressure Drop
Cathode	25 cfm	free
Output Tuner	4 cfm	3½″ H_2O
Klystron Body	5 gpm	10 psi
Klystron Collector	60 gpm	25 psi
Electromagnet	2 gpm	30 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage, Adjustable to	100 Vdc
Current, Adjustable to	20 Adc

MAXIMUM RATINGS

BEAM VOLTAGE	26 kVdc
BEAM CURRENT	8.5 Adc
BEAM INPUT POWER	200 kW
BODY CURRENT	200 mAdc
COLLECTOR DISSIPATION	200 kW
INLET COOLANT PRESSURE	125 psig
COOLANT OUTLET TEMPERATURE	80 °C
LOAD VSWR (NON DESTRUCTIVE)	1.5:1

TYPICAL OPERATION

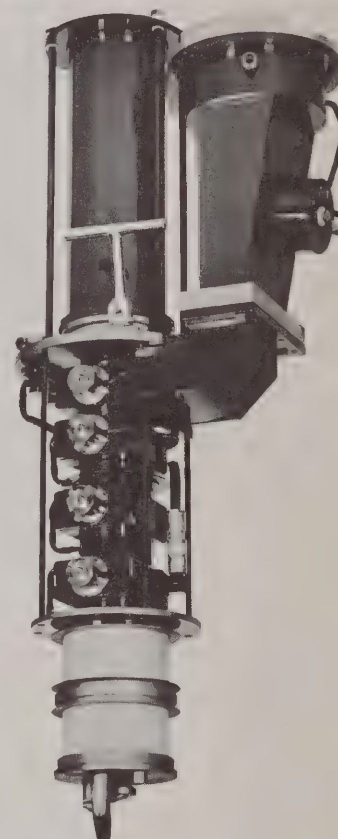
Frequency	1.3 GHz
Output Power	62 kW
Driving Power	20 W
Power Gain	34.9 db
Beam Voltage	25 kVdc
Beam Current	8 Adc
Body Current	150 mAdc
Efficiency	32.3 %
Electromagnet Current	16 Adc

For additional data or information regarding a specific application, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070.

E I M A C
Division of Varian
S A N C A R L O S
C A L I F O R N I A

4KM70SJ
POWER AMPLIFIER S-BAND KLYSTRON

The EIMAC 4KM70SJ is a power-amplifier klystron designed to operate at frequencies from 1700 to 2400 megahertz with a rated output power of 20 kilowatts and a minimum gain of 40 decibels. This klystron was the first product of EIMAC'S High Power Microwave Tube Laboratory, established in 1961. The design of the 4KM70SJ is completely new, incorporating many recent advances in klystron technology.



A large EIMAC Matrix Type A cathode is used in the 4KM70SJ with cathode current loading of only 230 milliamperes per square centimeter. This light cathode loading assures long life. The electron gun has a confined flow configuration which minimizes focusing adjustments and produces a very stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting RF output or body current. Only one electromagnet power supply is required.

Four integral cavities are used in the 4KM70SJ. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc.

The 4KM70SJ incorporates a built-in vacuum pump, in the form of a titanium getter, which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the EIMAC Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-136, has been designed for use with the 4KM70SJ.

EIMAC Water Load WL-201 is recommended for use with this klystron.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7	volts
	Current	12	amperes
	Maximum Starting Current	24	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	AC Voltage (Nominal)	4	volts
	AC Current	20	amperes
	Power Gain	40	decibels
	Output Power	20	kilowatts
	Frequency Range	1700 to 2400	megahertz

MECHANICAL

Operating Position		Any
RF Coupling:	Input	Type N coaxial fitting
	Output	UG435A/U flange
Weight:	Klystron Only	90 lbs.
	H-136 Electromagnet	170 lbs.

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	20 cfm	free
Klystron Body	1.5 gpm	60 psi
Klystron Collector	18 gpm	40 psi
Electromagnet	1.5 gpm	25 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage	200	volts
Current	20	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	21	KILOVOLTS
DC BEAM CURRENT	4	AMPERES
DC BEAM INPUT POWER	70	KILOWATTS
DC BODY CURRENT	85	MILLIAMPERES
COLLECTOR DISSIPATION	70	KILOWATTS
INLET WATER PRESSURE	80	PSI
LOAD VSWR	1.5:1	

TYPICAL OPERATION

Frequency	2000	megahertz
Output Power	22.2	kilowatts
Driving Power	1	watt
Power Gain	43.5	decibels
DC Beam Voltage	20	kilovolts
DC Beam Current	2.8	amperes
DC Modulating-Anode Voltage	13	kilovolts
Beam Power Efficiency	40	percent
DC Body Current	60	milliamperes
3 db bandwidth	10	megahertz
Electromagnet Current	15	amperes

For additional information or information regarding a specific application, write to High Power Microwave Division, EIMAC Division of Varian, San Carlos, California.

Tentative Data

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

5KM1000SG

AMPLIFIER KLYSTRON
500 kW CW
2320-2456 MHz

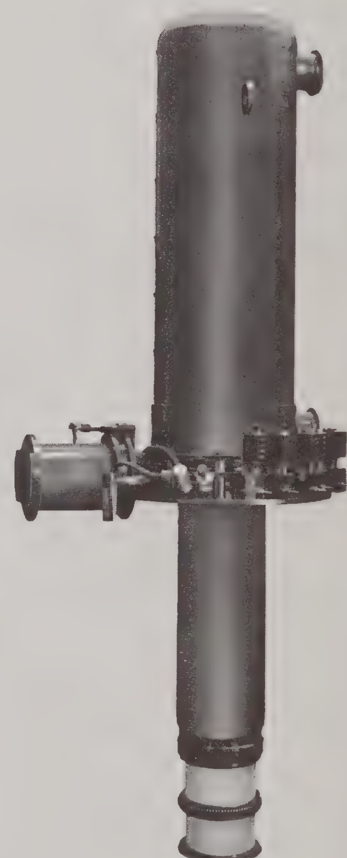
The EIMAC 5KM1000SG Power Amplifier Klystron was designed for use in the ground transmitters of spacecraft communications and tracking systems. Due to its high efficiency and gain, this klystron is also suitable for industrial microwave heating systems and CW linear accelerators demanding extremely high power levels at S-band.

The 5KM1000SG provides a minimum output power of 450 kW CW, with 50% minimum efficiency, 55 dB gain, and 20 MHz instantaneous bandwidth at the 1 dB points.

This klystron is extremely rugged and operable in any position, and is suitable for antenna mounting. The 5KM1000SG has five integral cavities, and features a unique half-wave beryllium oxide output window. The window is protected by an integral arc detector.

The 5KM1000SG is equipped with a modulating anode which should be connected to the body through a 20,000 ohm resistor to prevent damage to the klystron in the event of an arc between anode and cathode. A built-in VacIon® pump is supplied which maintains a low gas pressure and provides continuous indication of gas pressure during operation. The collector is rated at one megawatt, allowing amplitude modulation of the drive level or removal of drive power without overheating of the collector. Digital counters are provided to facilitate tuning.

The associated electromagnet, Catalog Number H-244, requires only a single power supply at fixed current for all operating conditions and power levels. In addition, an oil-filled tank including socket, high voltage cable-to-oil triaxial feedthrough, modulating anode connector and heater supply, is available as Catalog Number SK-131.



Printed in U.S.A.

CHARACTERISTICS

ELECTRICAL

Cathode	Impregnated, Unipotential
Heater Voltage	12.5 Vac
Heater Current	16.5 Aac
Tuning Range	2320-2456 MHz
Output Power	450 kW
Bandwidth (Instantaneous 1 dB)	20 MHz
Efficiency	50 %
Gain	55 dB
VacIon® Power Supply:	
Voltage	3.5 kVdc
Current	300 μAdc

MECHANICAL

Operating Position	Any between horizontal and vertical with collector up
Input rf Coupling	Type N
Output rf Coupling	WR-340 Waveguide

Water Cooling Requirements:	*Flow Rate*	*Pressure Drop*
Collector	240 gpm	25 psi
Body	30 gpm	90 psi
Output Drift Tube	10 gpm	90 psi
Output Window	4 gpm	90 psi
Solenoid and Socket Tank	10 gpm	90 psi

Weights:	
5KM1000SG	450 lbs.
H-244 Electromagnet	300 lbs.
SK-131 Socket Tank	300 lbs.

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage, adjustable to	450 Vdc
Current, adjustable to	25 Adc

MAXIMUM RATINGS

BEAM VOLTAGE	65 kVdc
BEAM CURRENT	16.5 Adc
BEAM INPUT POWER	1 MW
BODY CURRENT (WITHOUT DRIVE)	50 mAdc
BODY CURRENT (WITH DRIVE)	1.25 Adc
COLLECTOR DISSIPATION	1 MW
INLET COOLANT PRESSURE	125 psig
COOLANT OUTLET TEMPERATURE	76 °C
LOAD VSWR	1.2:1

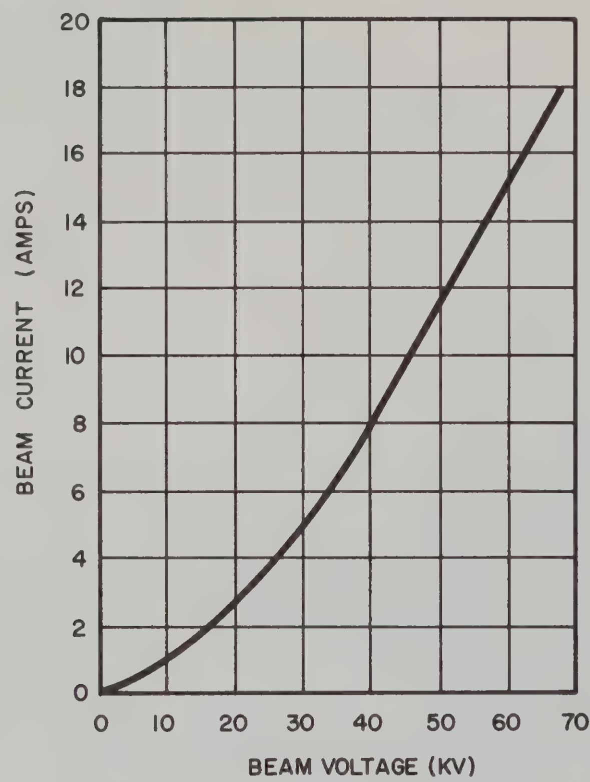
TYPICAL OPERATION

(Tuned for High Efficiency)

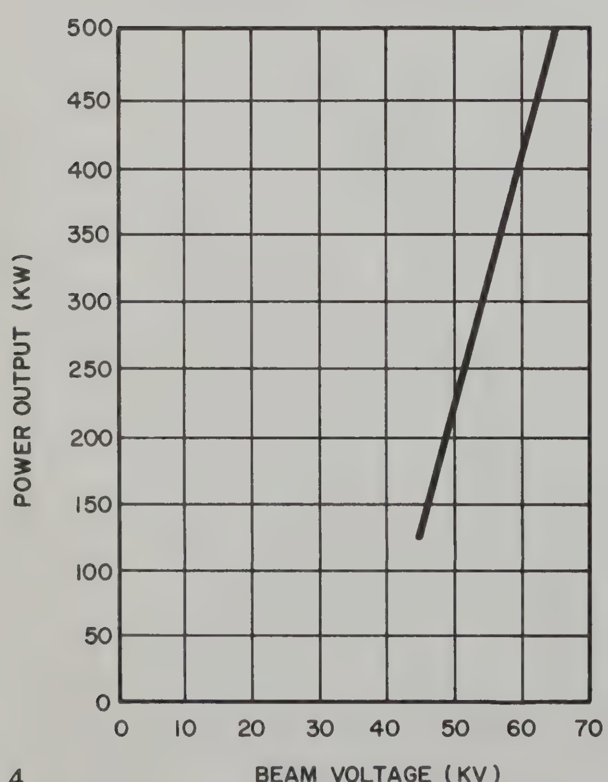
Frequency	2388 MHz
Output Power	500 kW
Driving Power	1 W
Power Gain	57 dB
Beam Voltage	63 kVdc
Beam Current	14.8 Adc
Body Current	1250 mAdc
Modulating Anode Voltage (with respect to cathode)	63 kVdc
1 dB Bandwidth	20 MHz
Efficiency	53 %
Electromagnet Current	20 Adc
Load VSWR	<1.1:1

For additional data or information regarding a specific application write to EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070.

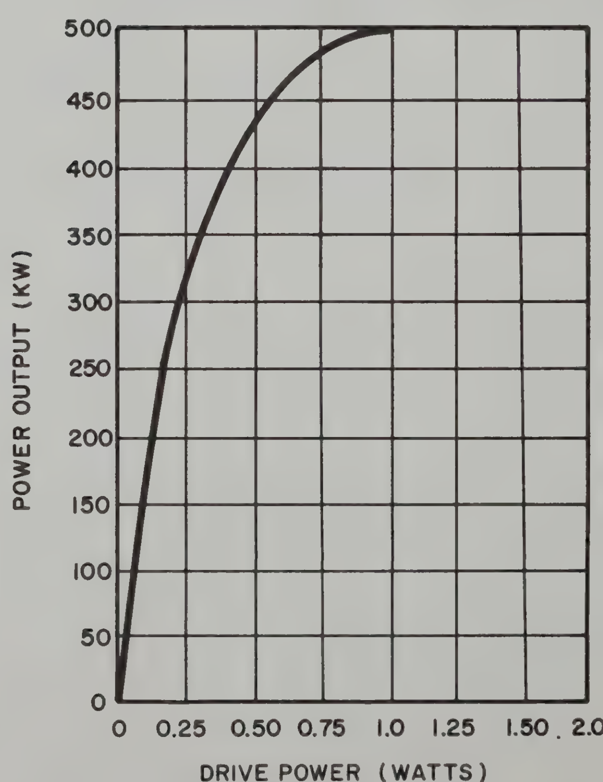
BEAM VOLTAGE VS. BEAM CURRENT



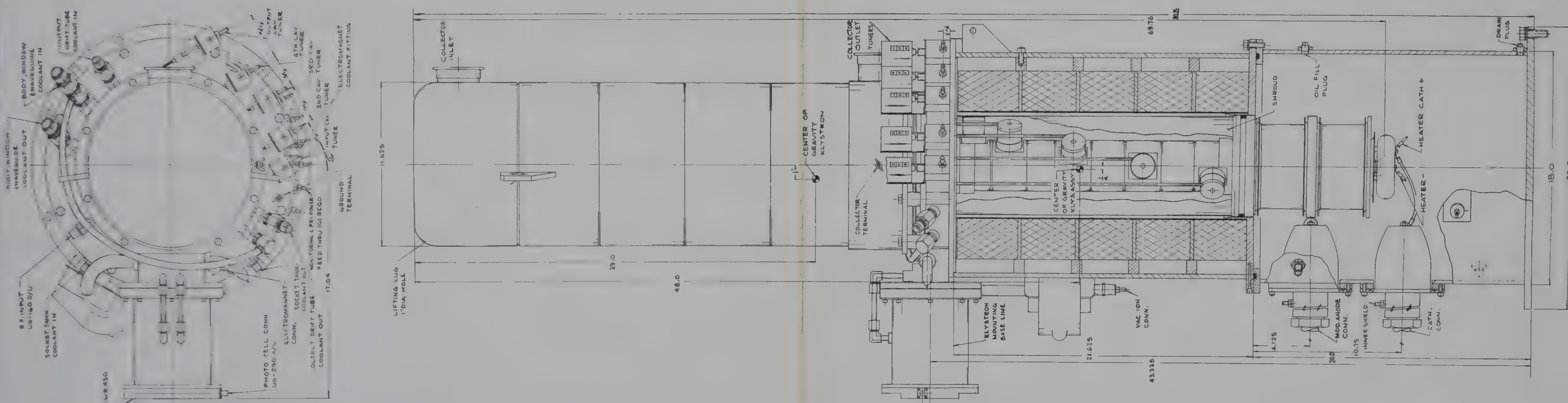
POWER OUTPUT VS. BEAM VOLTAGE



POWER OUTPUT VS. DRIVE POWER



Eimac 5KM1000SG



NOTE: ALL DIMS. SHOWN ARE NOMINAL

5KM1000SG KLYSTRON

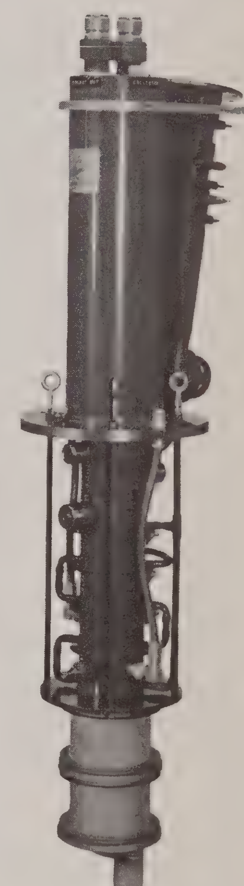
Tentative Data

X3033

PULSE AMPLIFIER KLYSTRON

200 kW min. Peak Power
3000 MHz

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA



The EIMAC X3033 is a pulse amplifier klystron designed for broad-band, long pulse service at a frequency of 3000 MHz. This klystron has a minimum fixed-tuned bandwidth of 50 MHz centered at this frequency and will deliver a minimum peak output power of 200 kilowatts, at 50 kilowatts average power, with a minimum power gain of 50 decibels.

Seven integral cavities are used in the klystron. The output circuit mates with a WR-284 S-band waveguide.

This klystron employs the EIMAC Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. The electron gun geometry is such that a typical switching voltage of 40 kilovolts is required for the modulating anode to provide the specified beam current, at the rated beam voltage of 40 kilovolts.

The tube incorporates a built-in VacIon® pump which maintains a low gas pressure, and also provides a means for continuously monitoring this pressure.

Catalog Number H-169 has been assigned to the magnetic circuitry for this tube.

CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential		
Minimum Heating Time	5	min
Heater: Voltage (±5%)	17	Vac
Current (nominal)	5	Aac
Power Gain (minimum)	50	dB
Peak Power Output	200	kw
Average Power Output	50	kW
Vac Ion Pump®: Voltage	3 to 4	kVdc
Current (0.1 megohm limiting resistor)	10	mAdc

MECHANICAL

Operating Position	Vertical, Cathode End Down
Input Coupling (rf)	Type N
Output Coupling (rf)	WR-284
Approximate Weight (tube only)	120 lbs
Approximate Weight (H-169 Magnetic Circuit)	500 lbs

Cooling: Air and Water	*Flow Rate*	*Pressure Drop*
Cathode (Air)	25 cfm	free
Collector	30 gpm	80 psi
Klystron Body	3 gpm	80 psi
Electromagnet	3.5 gpm	80 psi

Maximum Overall Dimensions (Klystron and Electromagnet):

Length (nominal)	43 inches
Diameter (nominal)	24 inches

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Four separate supplies (adjustable) - 65 Vdc @ 15 Adc

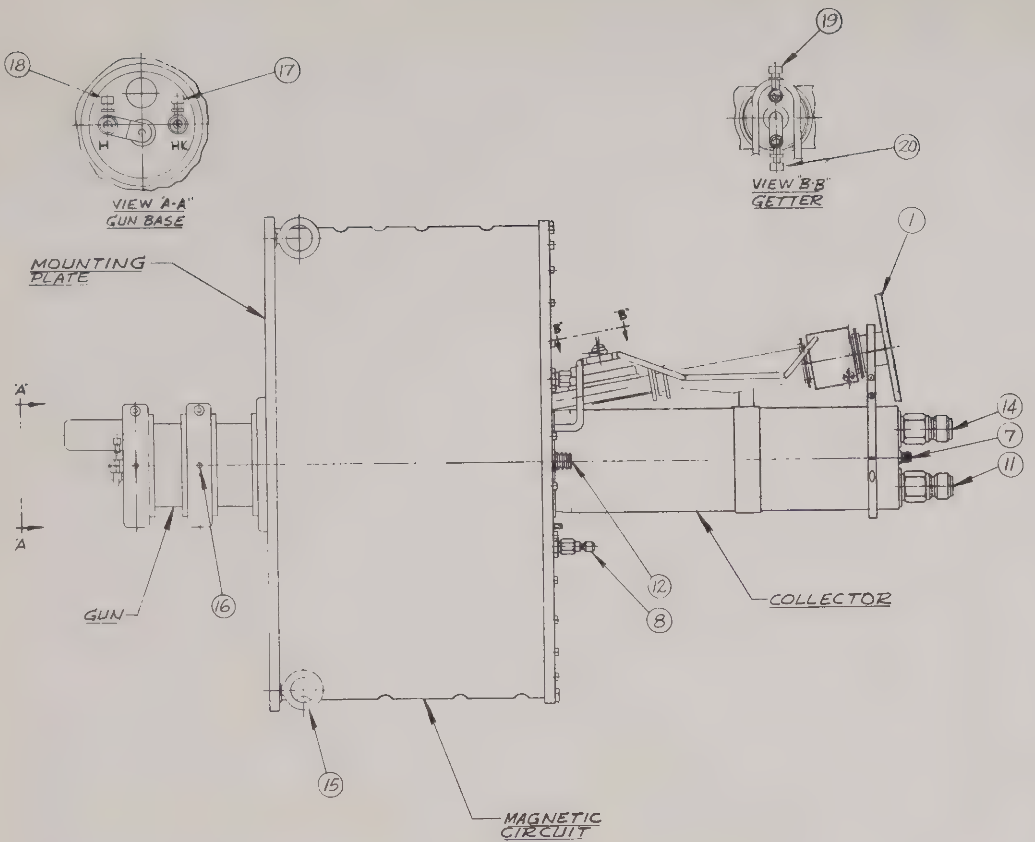
MAXIMUM RATINGS

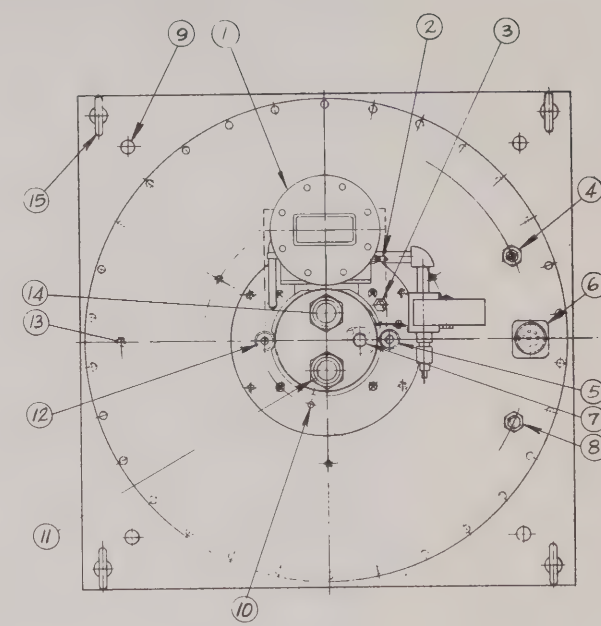
BEAM VOLTAGE	42	kVdc
PEAK BEAM CURRENT	18	A
PEAK MODULATING ANODE VOLTAGE	42	kv
AVERAGE BODY CURRENT	200	mAdc
COLLECTOR DISSIPATION	190	kW
DUTY CYCLE	0.25	
SEAL TEMPERATURE	175	°C
LOAD VSWR (non destructive)	1.5:1	
INLET WATER PRESSURE	135	PSIG
OUTLET WATER TEMPERATURE	80	°C

TYPICAL OPERATION, BROADBAND PULSE AMPLIFIER

Center Frequency	3000	MHz
Beam Voltage	38	kVdc
Peak Modulating-Anode Voltage	38	kv
Peak Beam Current	14.6	A
Average Body Current	170	mAdc
Peak Output Power	214	kw
Average Output Power	53.5	kW
Peak Drive Power	1.5	w
Peak Beam Power Efficiency	38.5	%
Pulse Width	2500	μs
Duty	0.25	
Bandwidth (3 dB)	90	MHz
Load VSWR	1.5:1	
Bandwidth (1 dB)	70	MHz

For additional data or information regarding a specific application, write to EIMAC, Division of Varian Associates, 301 Industrial Way, San Carlos, California 94070.





ITEM	DESCRIPTION
1	RF OUTPUT FLANGE UG-53/U
2	BODY; WATER OUT; MATES WITH HANSEN 2-S15; 2-S16; LL2-S16; 2-S17;
3	BODY; WATER IN; MATES WITH HANSEN 2-S15; 2-S16; LL2-S16; 2-S17;
4	MAGNET; WATER OUT; MATES WITH HANSEN 2-S15; 2-S16; LL2-S16; 2-S17;
5	INPUT; MATES WITH TYPE N PLUG (UG-21B/U etc.)
6	COIL CONNECTION MATES WITH AMPHENOL MS3106-24-6S
7	COLLECTOR CONNECTOR MATES WITH TYPE HN PLUG UG-59A/U etc.
8	MAGNET; WATER IN; MATES WITH HANSEN 2-S15; 2-S16; LL2-S16; 2-S17
9	MOUNTING HOLES
10	BODY GROUND 1/4-20UNC-2A
11	COLLECTOR; WATER OUT; MATES WITH HANSEN 8-S35; 8-S36; LL8-S36; 8-S37
12	LOADING MATES WITH TYPE N PLUG (UG-21B/U etc.) TO 50Ω 10WATT LOAD
13	MAGNET GROUND 1/4-20UNC-2A
14	COLLECTOR; WATER IN; MATES WITH HANSEN 8-S35; 8-S36; LL8-S36; 8-S37
15	LIFTING EYE BOLTS, 1 3/16 I.D. x 2 1/16 O.D. x 1/2-13UNC-2A
16	.203 DIA. HOLE, MOD. ANODE CONNECTION
17	HEATER; CATHODE CONNECTION "AMP" SOLDERLESS TERM # 321669
18	HEATER "AMP" SOLDERLESS TERM. # 322004
19	GETTER GROUND "AMP" SOLDERLESS TERM. # 321669
20	GETTER LEAD "AMP" SOLDERLESS TERM. # 322004
22	VARIAN VAC. ION PUMP. TAKES VARIAN 1 LITER MAGNET # 93-0011, PUMP TAKES VARIN HIGH VOLTAGE CABLE CONNECTOR # 924-0715

Eimac®

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

X3034
POWER AMPLIFIER
S-BAND
(1.1 KW CW)
TWT

The EIMAC X3034 is a power-amplifier TWT intended for use in broadband communications systems. It is designed to operate at frequencies from 1.7 to 2.1 gigahertz with a minimum output power of 1.1 kilowatts. The electron gun of this TWT has a confined flow configuration which makes focusing adjustments unnecessary and produces a stable beam. Excellent isolation between input and output is assured through the use of terminated severed circuit. This TWT incorporates the EIMAC Modulating Anode which provides a versatile means for controlling the beam.

EIMAC electromagnet assembly Type Number H-199 has been designed for use with the X3034.

CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential	
Heating Time	5 Min
Heater: Voltage (±5%)	5.6 Vac or Vdc
Current (Nominal)	3.8 Aac or Adc
Power Gain (Saturated)	20 db
Power Gain (Small Signal)	25 db
Output Power	1.1 kW
Frequency Range	1.7-2.1 GHz
Maximum Power Variation in any 50 MHz band (Note 1)	1 db

MECHANICAL

Maximum Dimensions:	
Length	34⅝ inches
Width	7⅛ inches
Depth	7½ inches
Weight (Including Electromagnet)	160 pounds
Input Coupling (rf)	Type N Coaxial
Output Coupling (rf)	⅞" coaxial, EIA STD RS-225
Mounting Position	Any

Cooling: Forced Air and Water	*Flow Rate*	*Pressure Drop*
Cathode	20 cfm	free
Body	1 gpm	50 psi
Collector	5 gpm	10 psi
Electromagnet	1.5 gpm	40 psi

 Printed in U.S.A.

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Upper Coil	Adjustable to 50 Vdc at 10 Adc
Lower Coil	Adjustable to 35 Vdc at 7 Adc

MAXIMUM RATINGS

BEAM VOLTAGE	13 kVdc
BEAM CURRENT	1 Adc
BEAM INPUT POWER	11 kW
BODY CURRENT	25 mAdc
COLLECTOR DISSIPATION	11 kW
LOAD VSWR	1.2:1
WATER INLET TEMPERATURE	50 °C

TYPICAL OPERATION

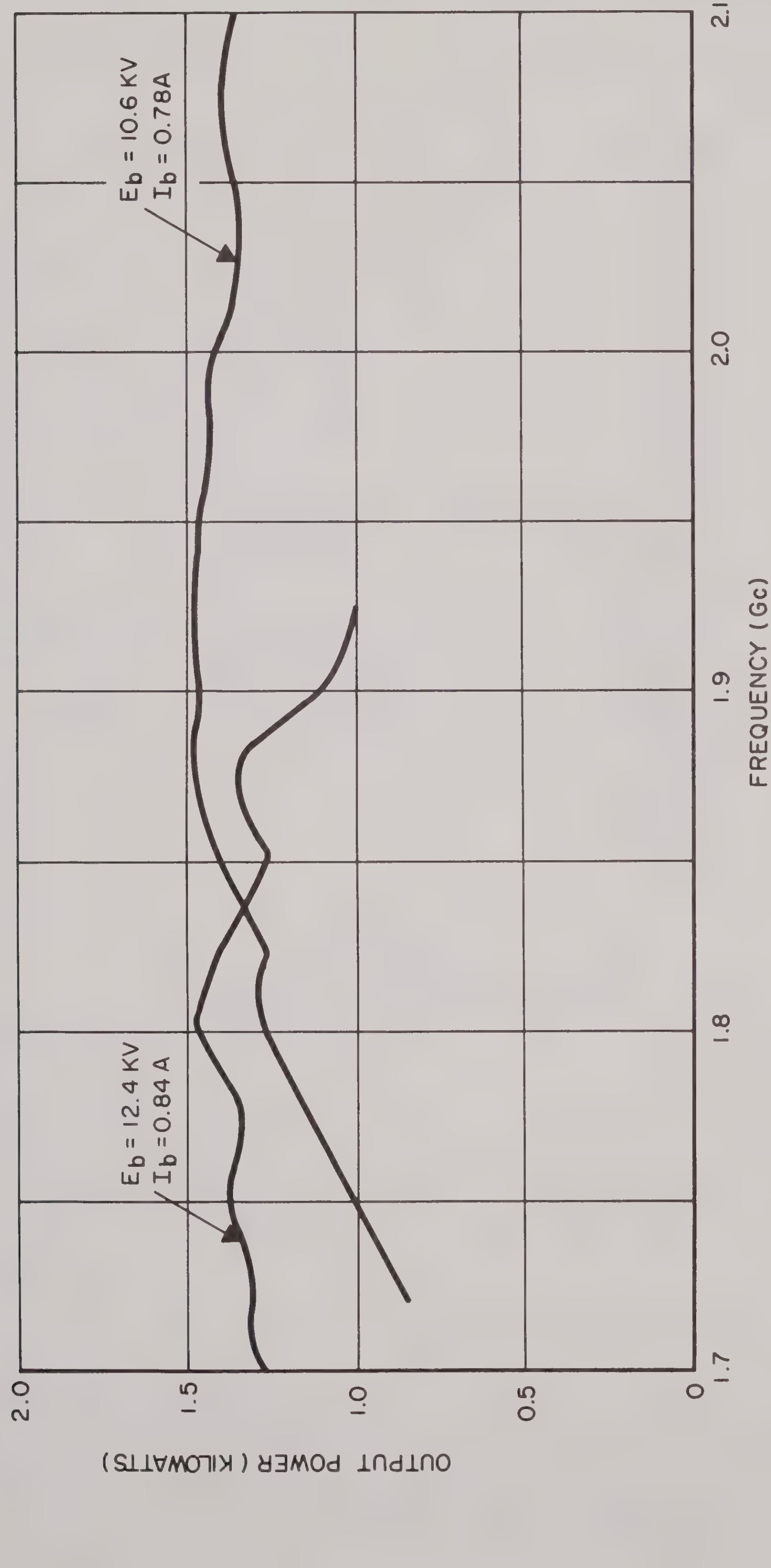
Frequency	1.7	1.8	1.9	2.0	2.1	GHz
Beam Voltage	12.4	12.4	10.6	10.6	10.6	kVdc
Beam Current	0.84	0.84	0.78	0.78	0.78	Adc
Mod Anode Voltage (with respect to cathode)	10.0	10.0	9.7	9.7	9.7	kVdc
Body Current	13	13	17	17	17	mAdc
Drive Power	10	10	10	10	10	W
Output Power	1.25	1.47	1.47	1.43	1.36	kW
Gain	20.9	21.6	21.6	21.5	21.3	db
Electromagnet Currents						
Upper Coil	9.5	9.5	9.5	9.5	9.5	Adc
Lower Coil	6	6	6	6	6	Adc

NOTE:

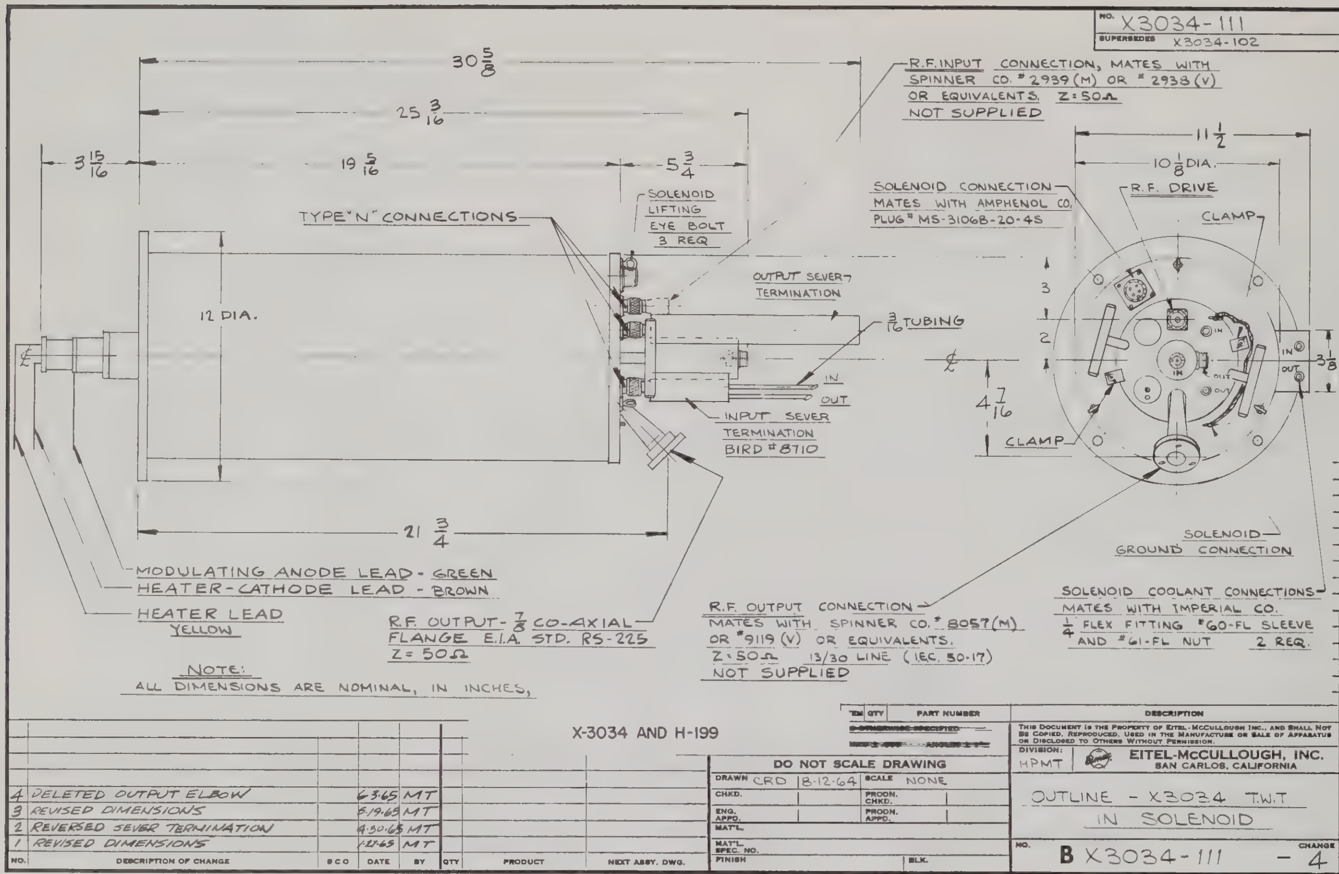
(1) Beam Voltage may be optimized for each 50 MHz segment.

(2) In the event of rapid change in VSWR such as caused by a transmission line arc, the rf drive must be removed in 20 milliseconds. It is recommended that an isolator be inserted in the output line between a re-active filter and the TWT.

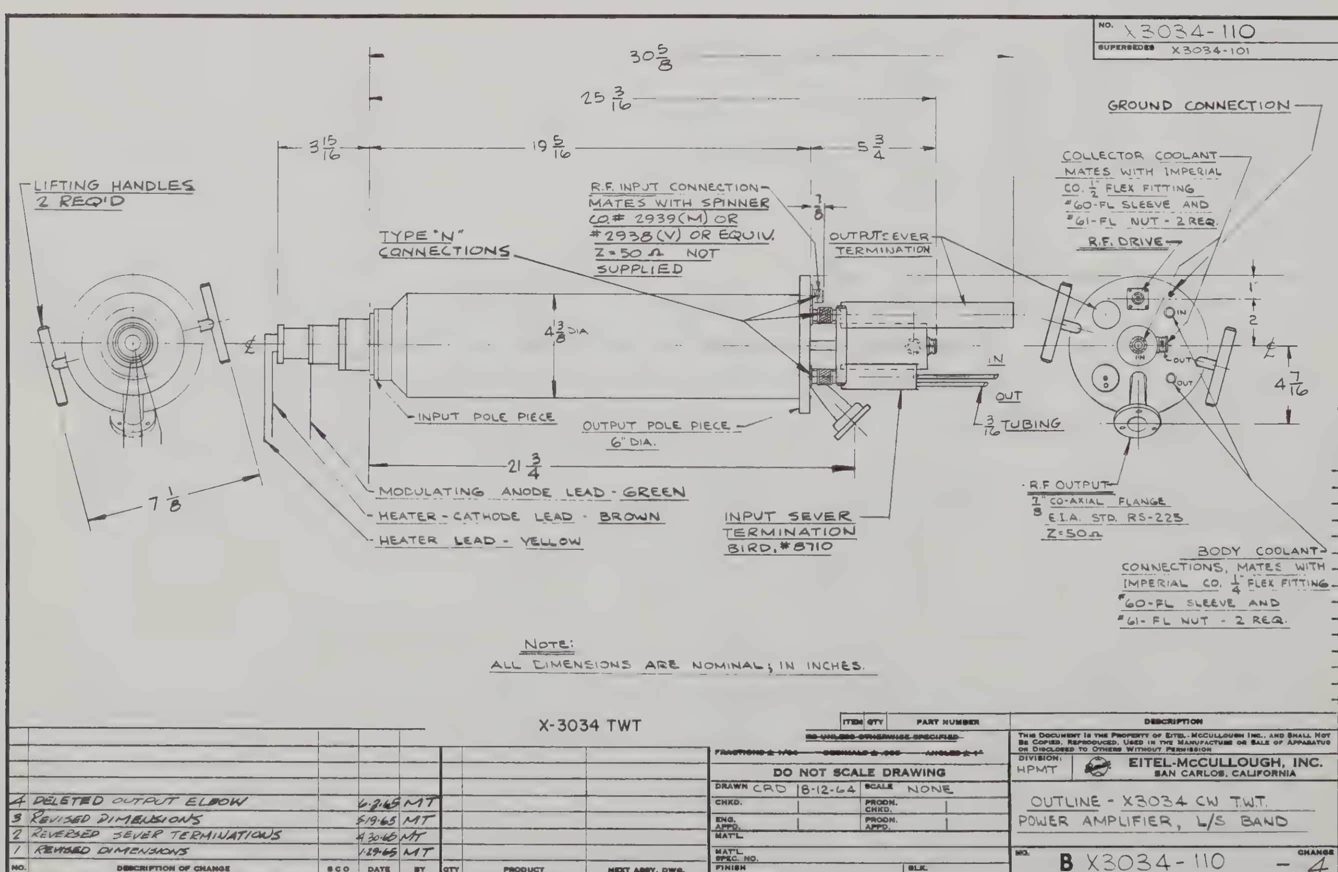
(3) The nominal input and output impedances are designed to work into 50 ohm transmission lines.


E_b = 10.6 KV
I_b = 0.78A
E_b = 12.4 KV
I_b = 0.84 A
OUTPUT POWER (KILOWATTS)
2.0
1.5
1.0
0.5
0
1.7
1.8
1.9
2.0
2.1
FREQUENCY (Gc)

X-3034



NO. X3034-111
SUPERSEDED X3034-102
30 5/8
25 3/16
3 15/16
19 5/16
5 3/4
R.F. INPUT CONNECTION, MATES WITH SPINNER CO. # 2939 (M) OR # 2938 (V) OR EQUIVALENTS. Z=50Ω NOT SUPPLIED
11 1/2
10 1/8 DIA.
SOLENOID CONNECTION MATES WITH AMPHENOL CO. PLUG # MS-3106B-20-4S
R.F. DRIVE
CLAMP
TYPE "N" CONNECTIONS
SOLENOID LIFTING EYE BOLT 3 REQ
OUTPUT SEVER TERMINATION
12 DIA.
3/16 TUBING
IN
OUT
INPUT SEVER TERMINATION BIRD # 8710
4 7/16
CLAMP
3 1/8
21 3/4
SOLENOID GROUND CONNECTION
MODULATING ANODE LEAD - GREEN
HEATER-CATHODE LEAD - BROWN
HEATER LEAD YELLOW
R.F. OUTPUT - 7/8 CO-AXIAL FLANGE E.I.A. STD. RS-225 Z=50Ω
R.F. OUTPUT CONNECTION MATES WITH SPINNER CO. # 8057 (M) OR # 9119 (V) OR EQUIVALENTS. Z=50Ω 13/30 LINE (IEC. 50-17) NOT SUPPLIED
SOLENOID COOLANT CONNECTIONS MATES WITH IMPERIAL CO. 1/4 FLEX FITTING # 60-FL SLEEVE AND # 61-FL NUT 2 REQ.
NOTE: ALL DIMENSIONS ARE NOMINAL, IN INCHES.
X-3034 AND H-199
4 DELETED OUTPUT ELBOW 6-3-65 MT
3 REVISED DIMENSIONS 5-19-65 MT
2 REVERSED SEVER TERMINATION 4-30-65 MT
1 REVISED DIMENSIONS 1-21-65 MT
DO NOT SCALE DRAWING
DRAWN CRD 8-12-64 SCALE NONE
DIVISION: HPMT
EITEL-McCULLOUGH, INC. SAN CARLOS, CALIFORNIA
OUTLINE - X3034 T.W.T. IN SOLENOID
B X3034-111 CHANGE 4



NO. X3034-110
SUPERSEDED X3034-101
30 5/8
25 3/16
3 15/16
19 5/16
5 3/4
GROUND CONNECTION
LIFTING HANDLES 2 REQ'D
R.F. INPUT CONNECTION MATES WITH SPINNER CO. # 2939 (M) OR # 2938 (V) OR EQUIV. Z=50Ω NOT SUPPLIED
7/8
OUTPUT SEVER TERMINATION
COLLECTOR COOLANT MATES WITH IMPERIAL CO. 1/2 FLEX FITTING # 60-FL SLEEVE AND # 61-FL NUT - 2 REQ.
R.F. DRIVE
TYPE "N" CONNECTIONS
4 13/16 DIA
IN
OUT
3/16 TUBING
4 7/16
INPUT POLE PIECE
OUTPUT POLE PIECE 6" DIA.
21 3/4
7 1/8
MODULATING ANODE LEAD - GREEN
HEATER - CATHODE LEAD - BROWN
HEATER LEAD - YELLOW
INPUT SEVER TERMINATION BIRD, # 8710
R.F. OUTPUT 7/8" CO-AXIAL FLANGE E.I.A. STD. RS-225 Z=50Ω
BODY COOLANT CONNECTIONS, MATES WITH IMPERIAL CO. 1/4" FLEX FITTING # 60-FL SLEEVE AND # 61-FL NUT - 2 REQ.
NOTE: ALL DIMENSIONS ARE NOMINAL; IN INCHES.
X-3034 TWT
4 DELETED OUTPUT ELBOW 6-2-65 MT
3 REVISED DIMENSIONS 5-19-65 MT
2 REVERSED SEVER TERMINATIONS 4-30-65 MT
1 REVISED DIMENSIONS 1-29-65 MT
DO NOT SCALE DRAWING
DRAWN CRD 8-12-64 SCALE NONE
DIVISION: HPMT
EITEL-McCULLOUGH, INC. SAN CARLOS, CALIFORNIA
OUTLINE - X3034 CW T.W.T. POWER AMPLIFIER, L/S BAND
B X3034-110 CHANGE 4

Eimac®

E I M A C
Division of Varian

EM-778A

TRAVELING WAVE TUBE
5.0-11.0 GHz
1 W C.W. Min.
60 dB Min. S.S.G.

The EM778A is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude, and temperature. These tubes are focussed by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers or radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	5.0-11.0 GHz
Saturated Power Output (Min)	1 W
(Typical)	2 W
Small Signal Gain (Min)	60 dB
(Typical)	65 dB
Saturated Gain (Min)	55 dB
(Typical)	60 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

Printed in U.S.A.

ELECTRICAL

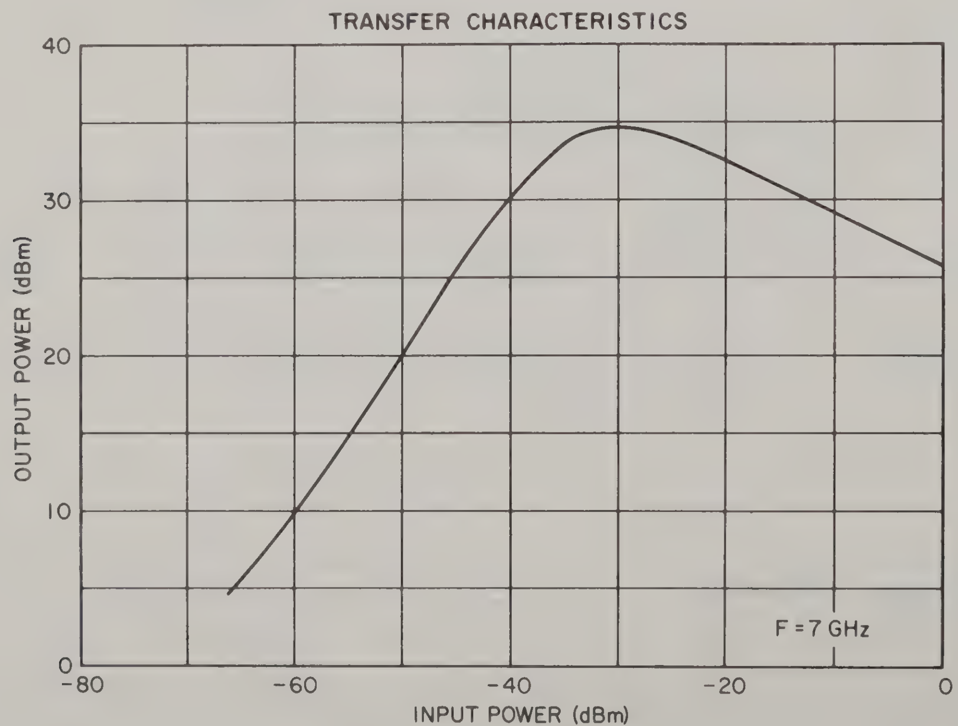
	Min.	Max.	Units
Cathode Voltage	-2700	-3000	V
Cathode Current		30	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage		GND	ground
Collector Voltage		GND	ground
Heater Voltage (Nominal)		6.3	V
Heater Current (Nominal)		0.6	A

ENVIRONMENT

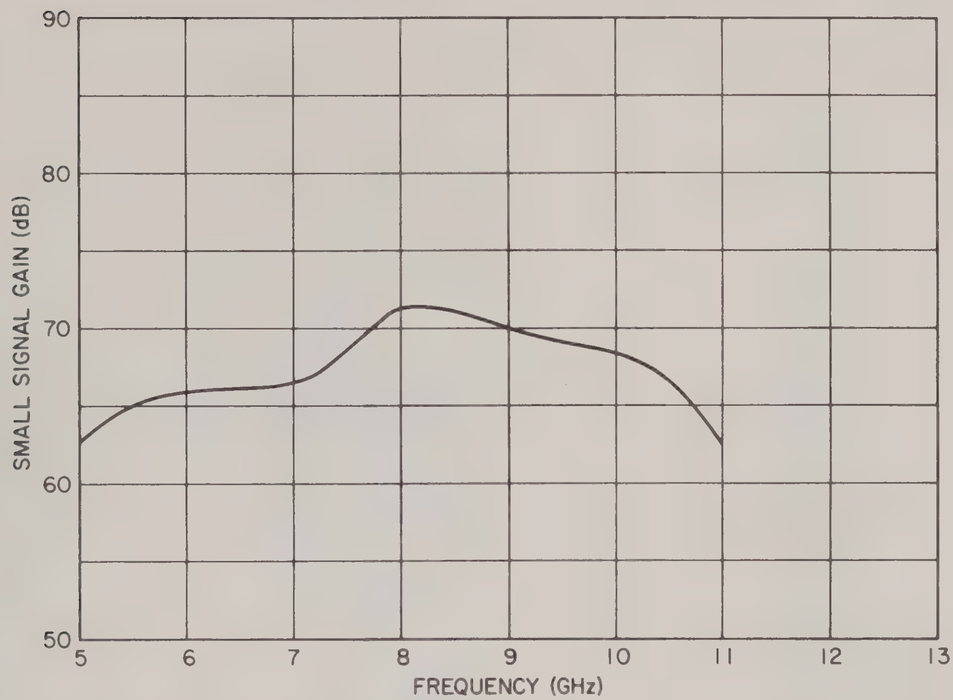
Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

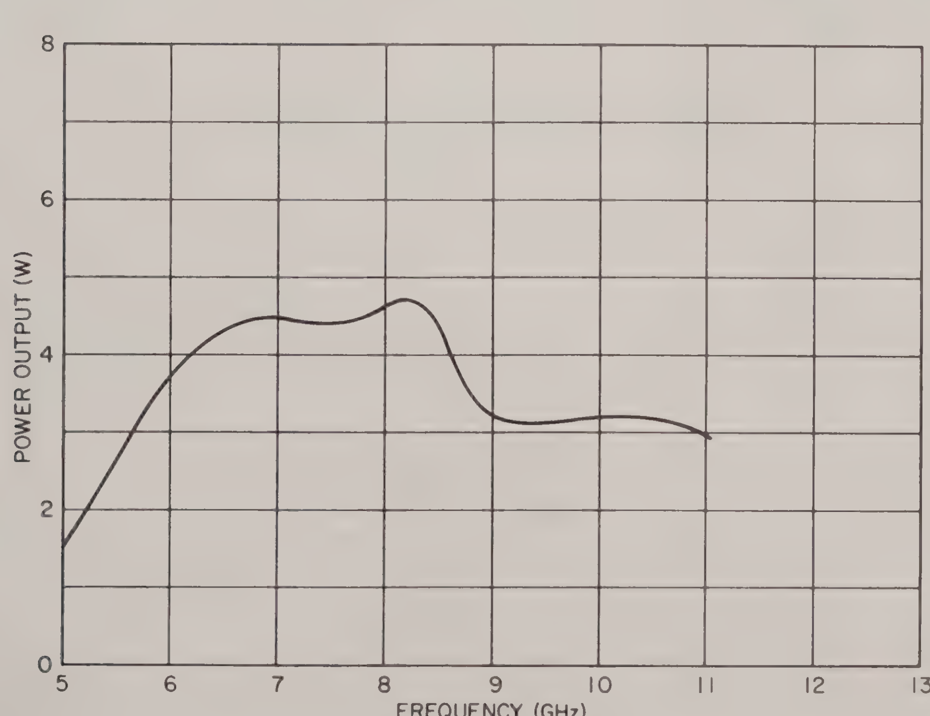
Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4-1/2 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

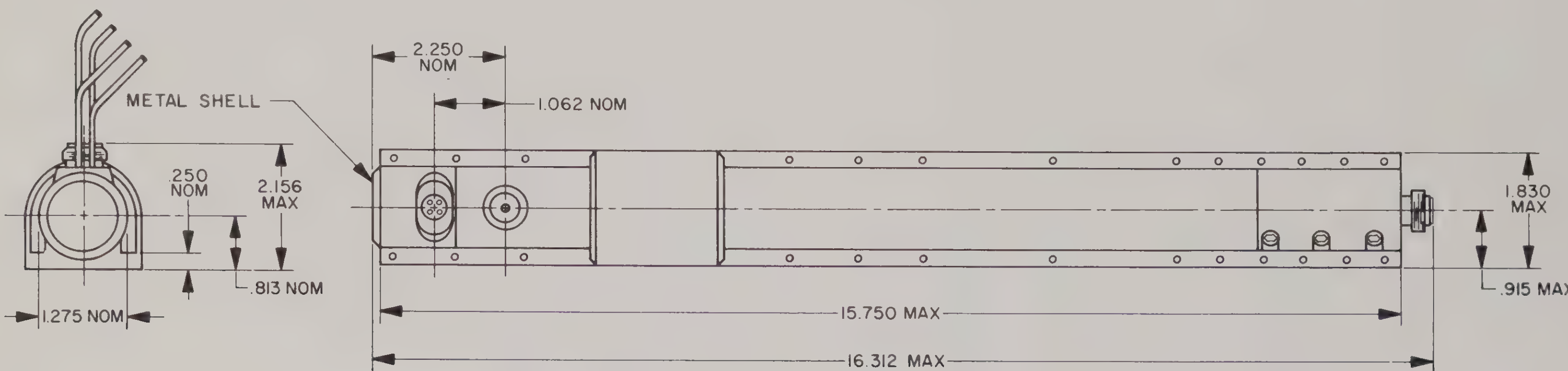


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
GREEN	FOCUS ELECTRODE
BLACK	BODY GROUND

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Division of Varian

EM-1006B

TRAVELING WAVE TUBE
2.0-4.0 GHz
1 W C.W. Min.
50 dB Min. S.S.G.

The EM1006B is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude, and temperature. These tubes are focused by a fully temperature compensated periodic permanent magnet array. Typical applications are in ECM and radar augmenters, and in communications, airborne radar, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	2.0-4.0 GHz
Saturated Power Output (Min)	1 W
(Typical)	2 W
Small Signal Gain (Min)	50 dB
(Typical)	50 dB
Saturated Gain (Min)	40 dB
(Typical)	50 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

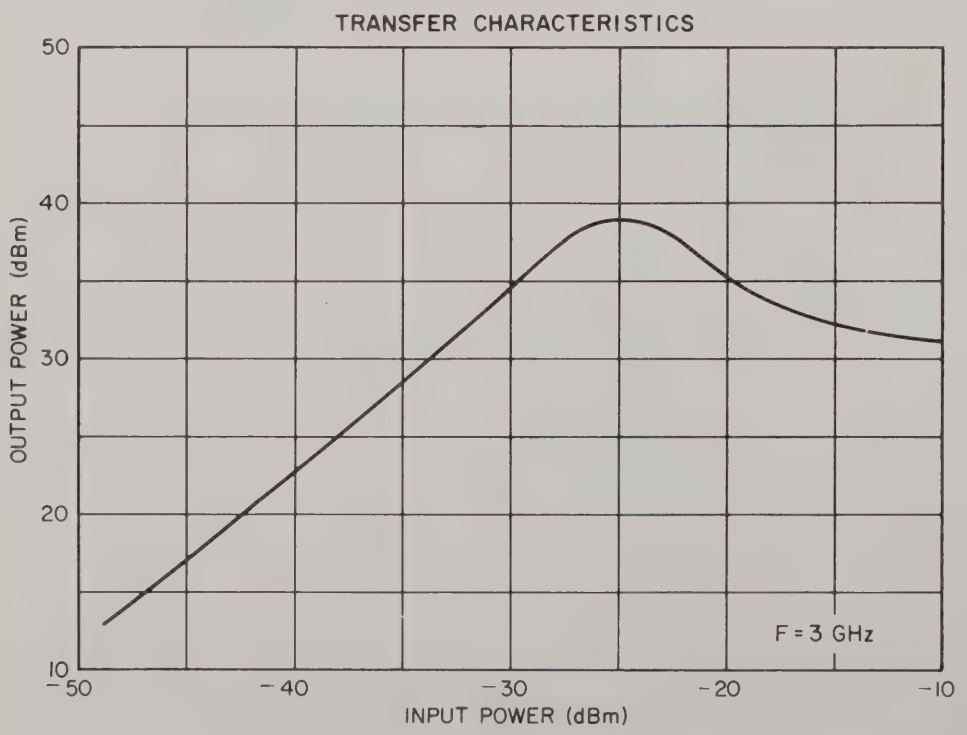
	Min.	Max.	Units
Cathode Voltage	-1100	-1300	V
Cathode Current		40	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.8		A

ENVIRONMENT

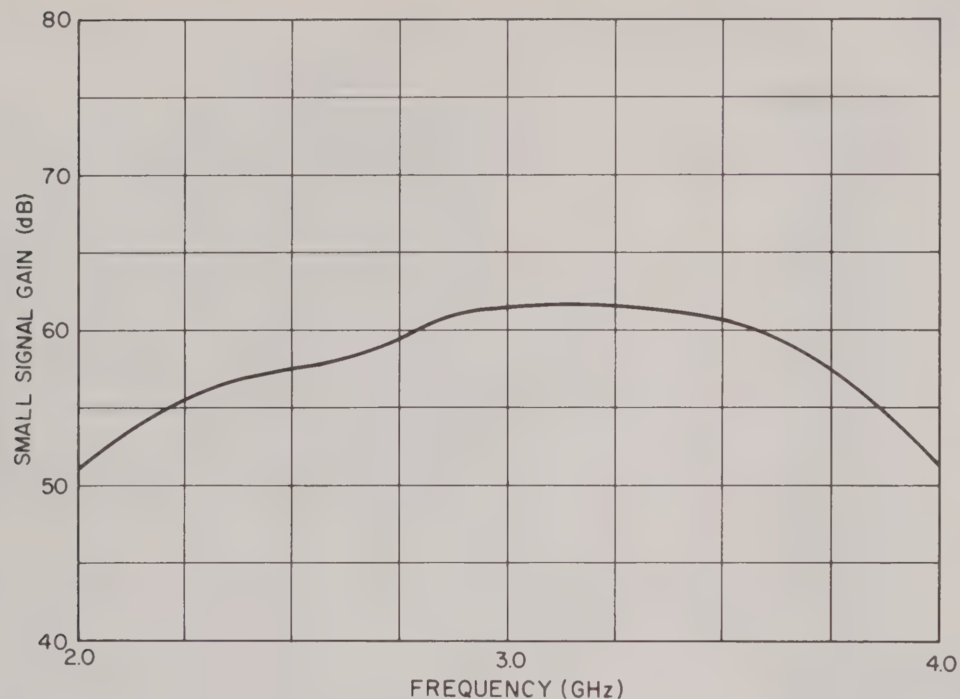
Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

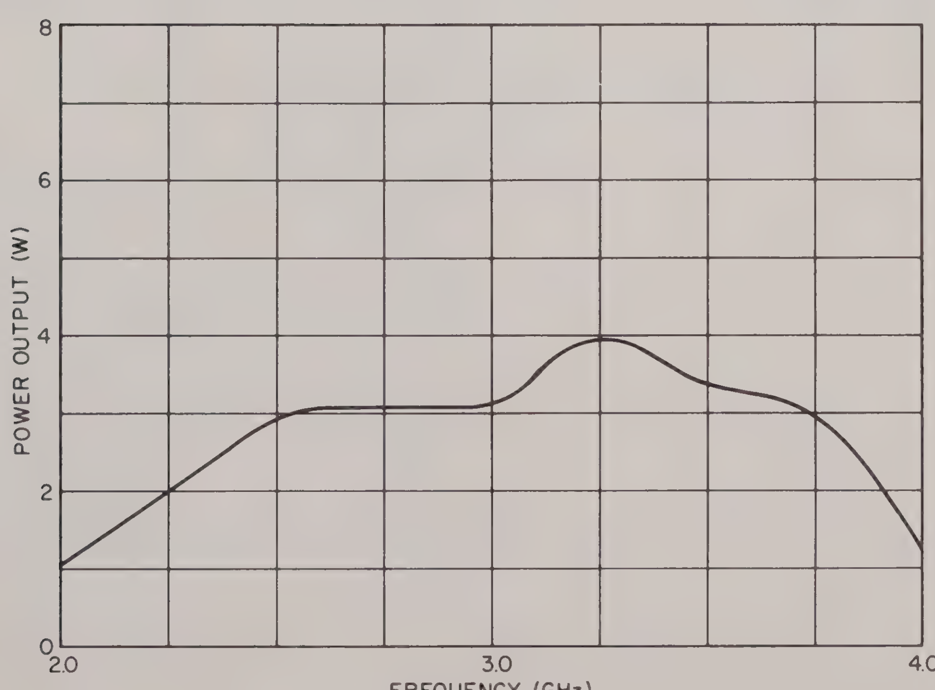
Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4-1/2 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

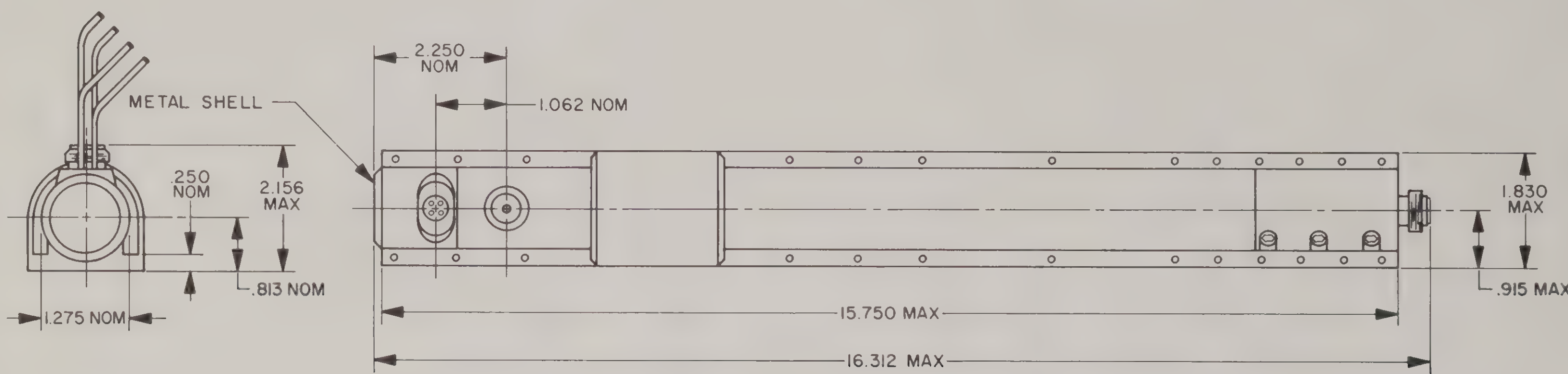


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
GREEN	FOCUS ELECTRODE
BLACK	BODY GROUND

EIMAC

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EM-1010B

TRAVELING WAVE TUBE

4.0-8.0 GHz

1 W C.W. Min.

60 dB Min. S.S.G.

The EM1010B is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude, and temperature. These tubes are focused by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers or radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	4.0-8.0 GHz
Saturated Power Output (Min)	1 W
(Typical)	3 W
Small Signal Gain (Min)	60 dB
(Typical)	65 dB
Saturated Gain (Min)	55 dB
(Typical)	60 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

	Min.	Max.	Units
Cathode Voltage	-2400	-2600	V
Cathode Current		30	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.6		A

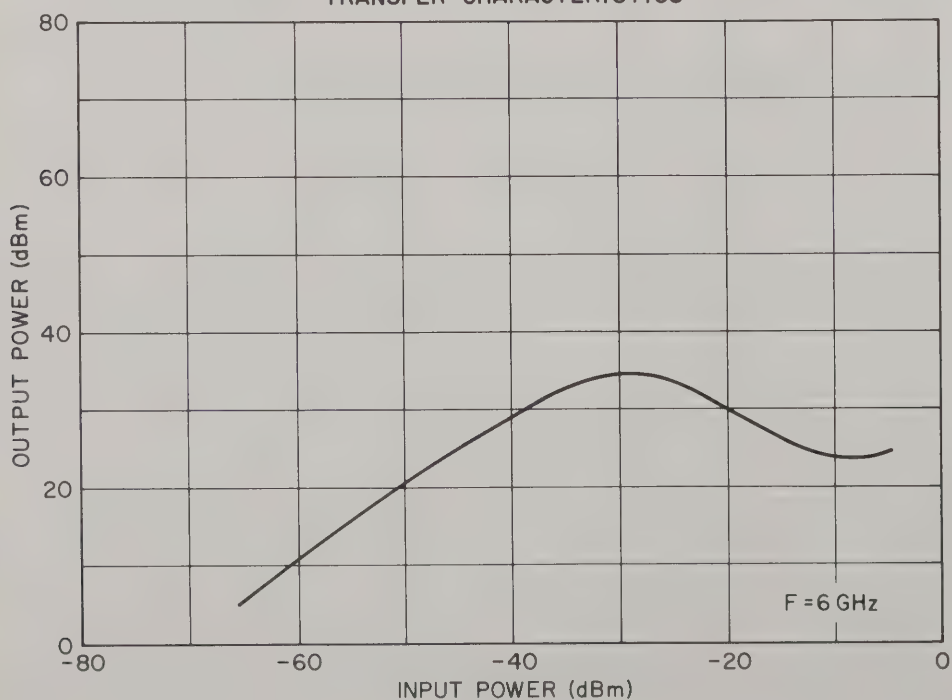
ENVIRONMENT

Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

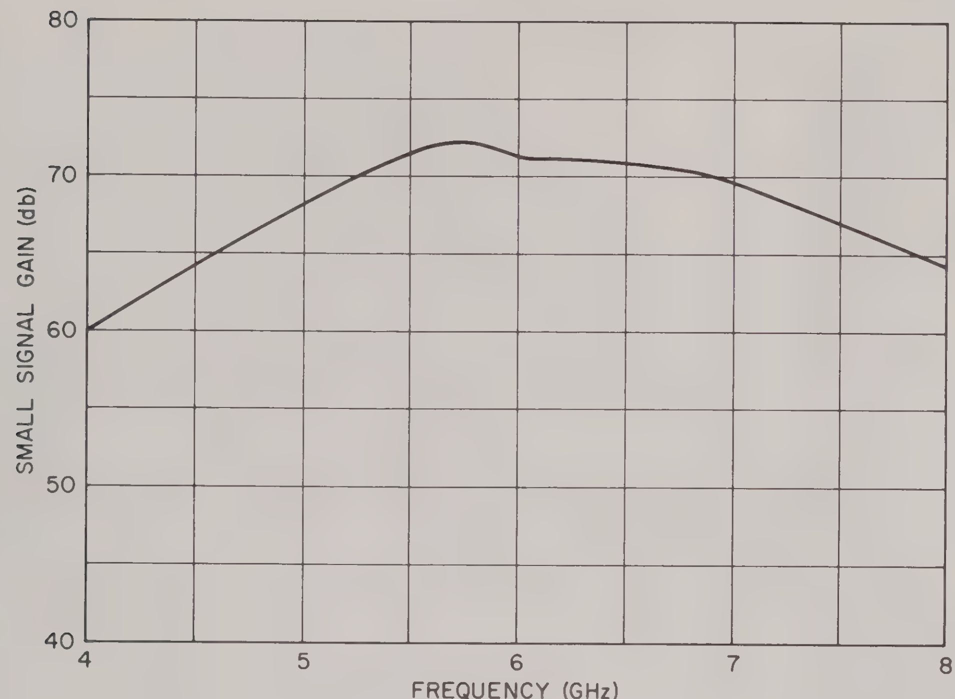
MECHANICAL

Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4-1/2 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

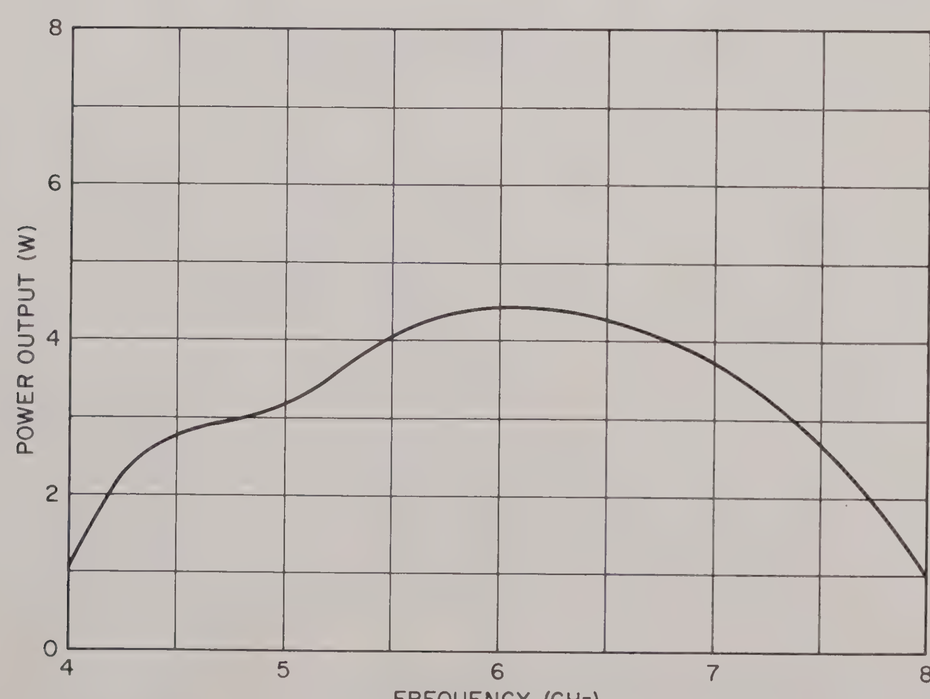
TRANSFER CHARACTERISTICS

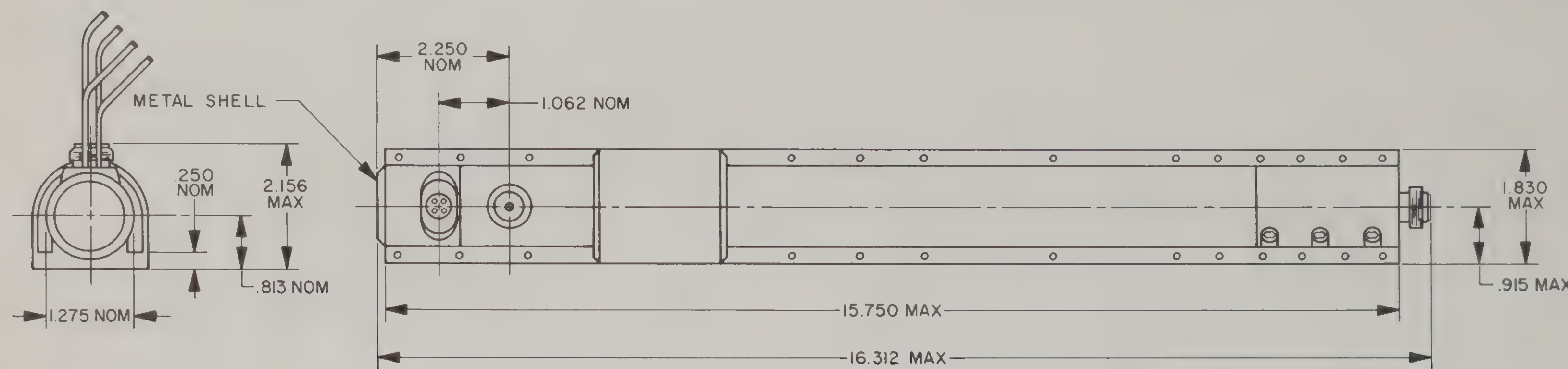


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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CALIFORNIA

EM-1015B

TRAVELING WAVE TUBE
4.0-8.0 GHz
3 W C.W. Min.
60 dB Min. S.S.G.

The EM1015B is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude and temperature. These tubes are focussed by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers or radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	4.0-8.0 GHz
Saturated Power Output (Min)	3 W
(Typical)	5 W
Small Signal Gain (Min)	60 dB
(Typical)	65 dB
Saturated Gain (Min)	55 dB
(Typical)	60 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

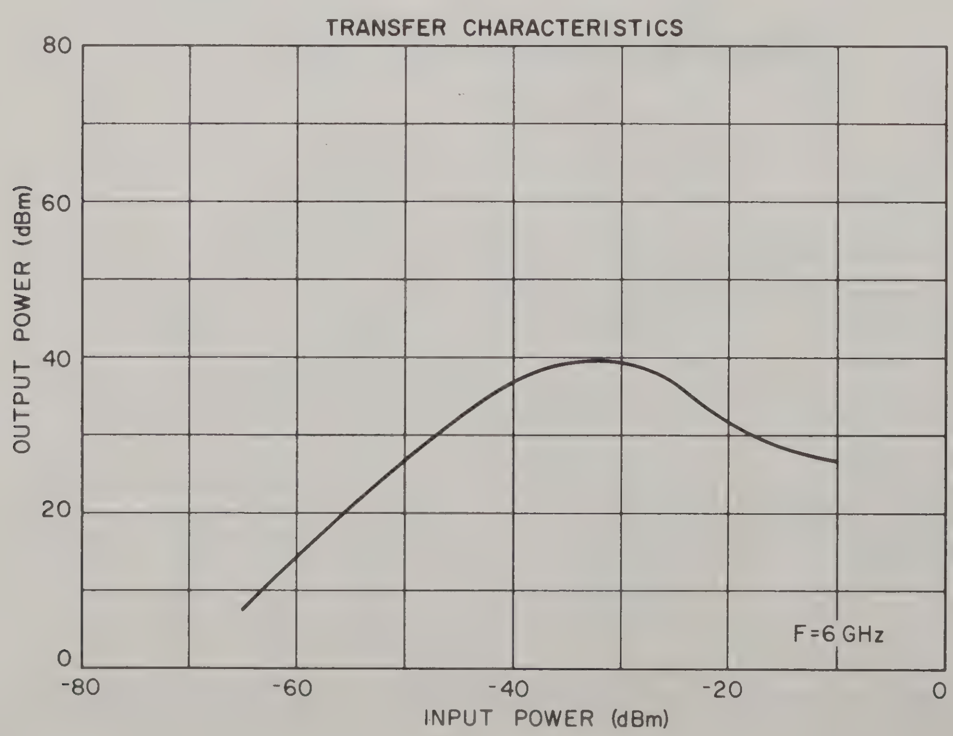
	Min.	Max.	Units
Cathode Voltage	-2300	-2600	V
Cathode Current		40	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.6		A

ENVIRONMENT

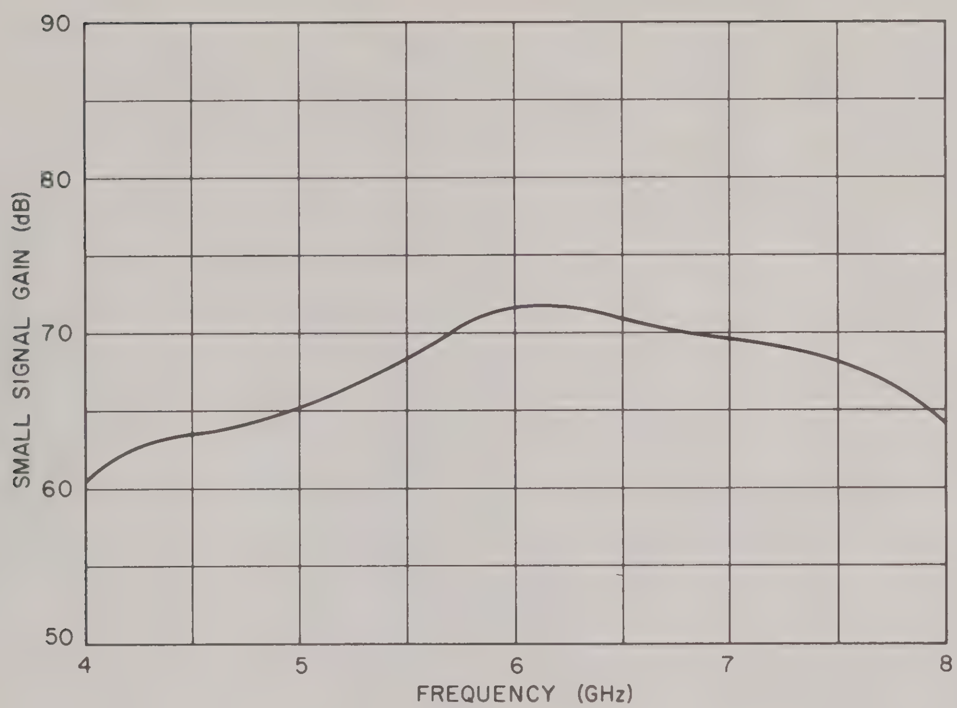
Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

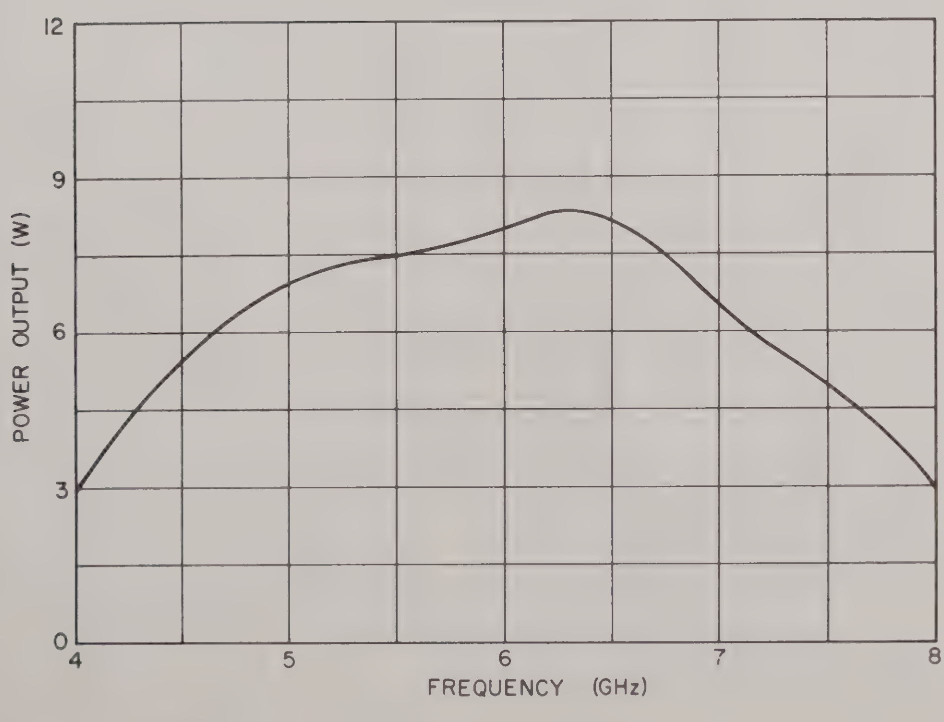
Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4.5 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

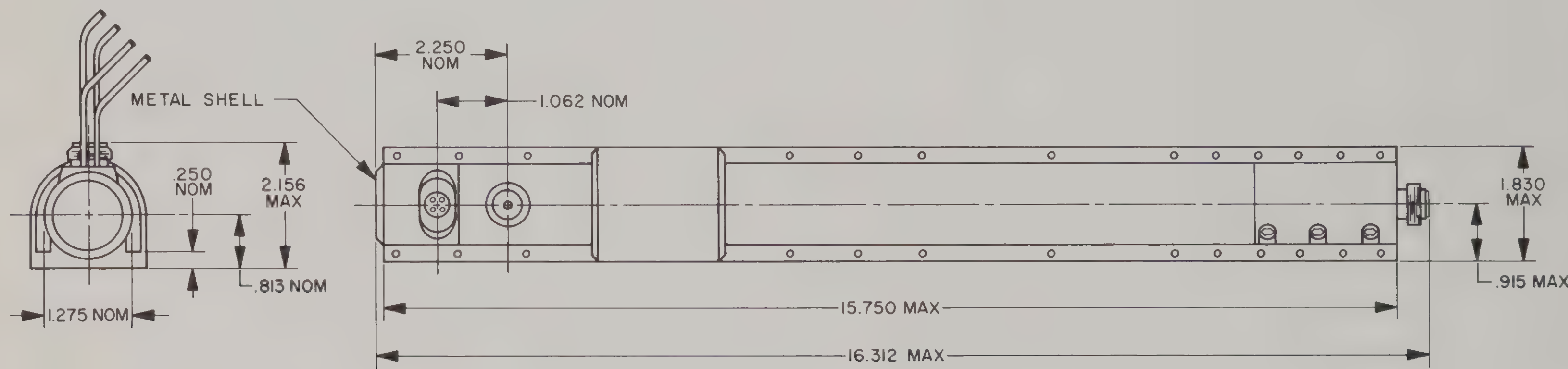


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
GREEN	FOCUS ELECTRODE
BLACK	BODY GROUND

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EM-1030C

TRAVELING WAVE TUBE
7.0-11.0 GHz
5 W C.W. Min.
60 dB Min.

The EM1030C is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude and temperature. These tubes are focussed by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers or radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	7.0-11.0 GHz
Saturated Power Output (Min)	5 W
(Typical)	7 W
Small Signal Gain (Min)	60 dB
(Typical)	65 dB
Saturated Gain (Min)	55 dB
(Typical)	60 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

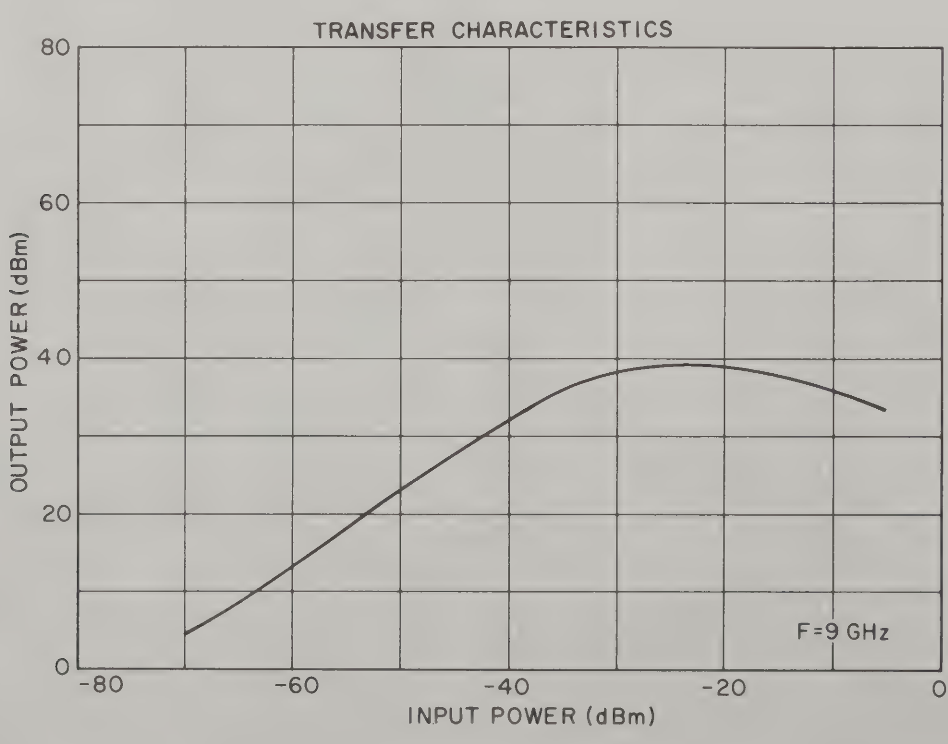
	Min.	Max.	Units
Cathode Voltage	-2800	-3400	V
Cathode Current		40	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.6		A

ENVIRONMENT

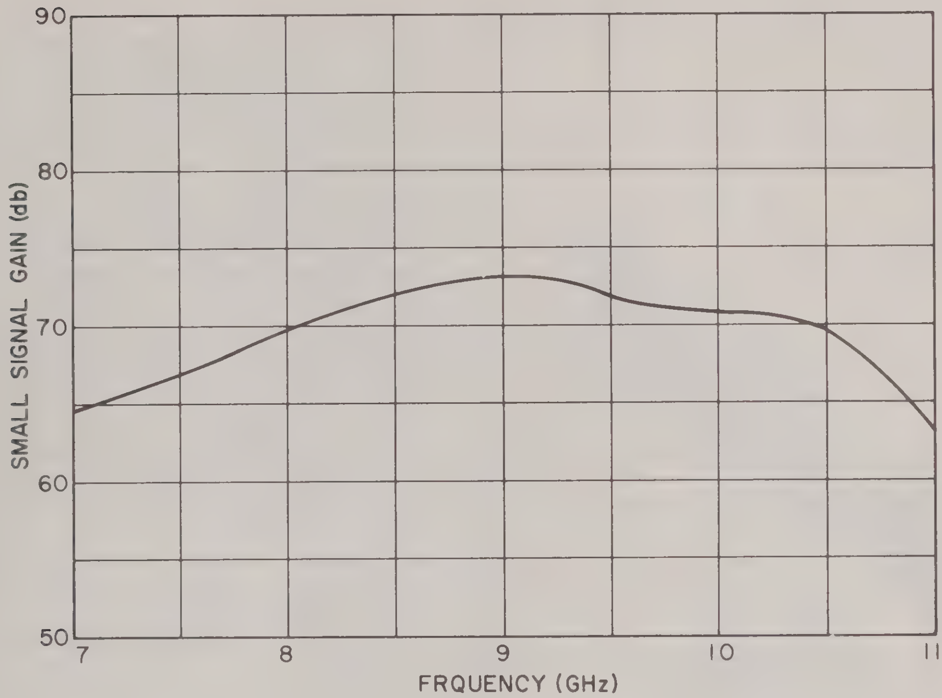
Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

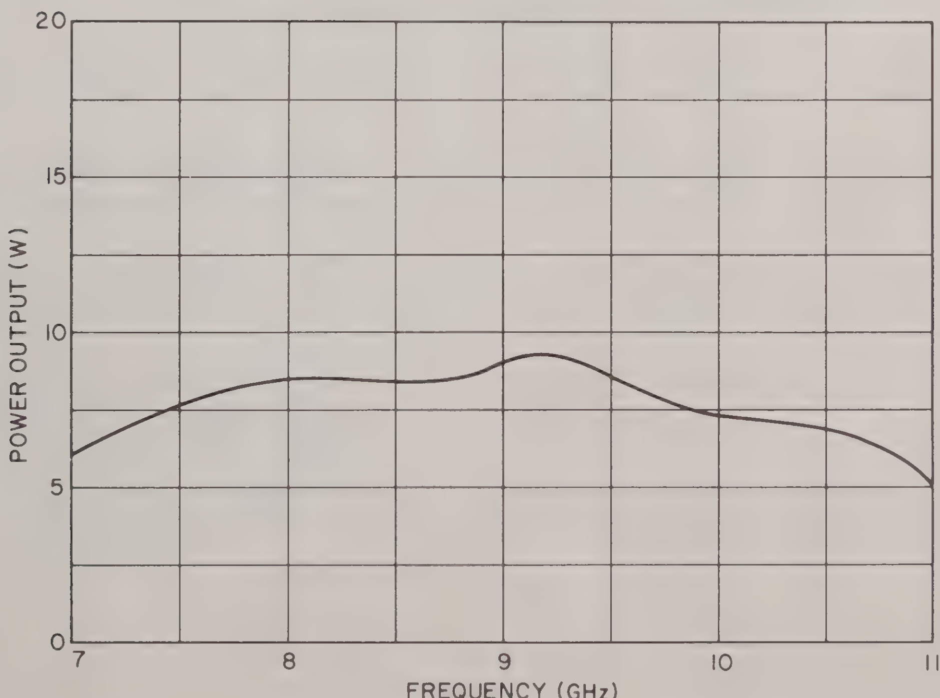
Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4.5 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

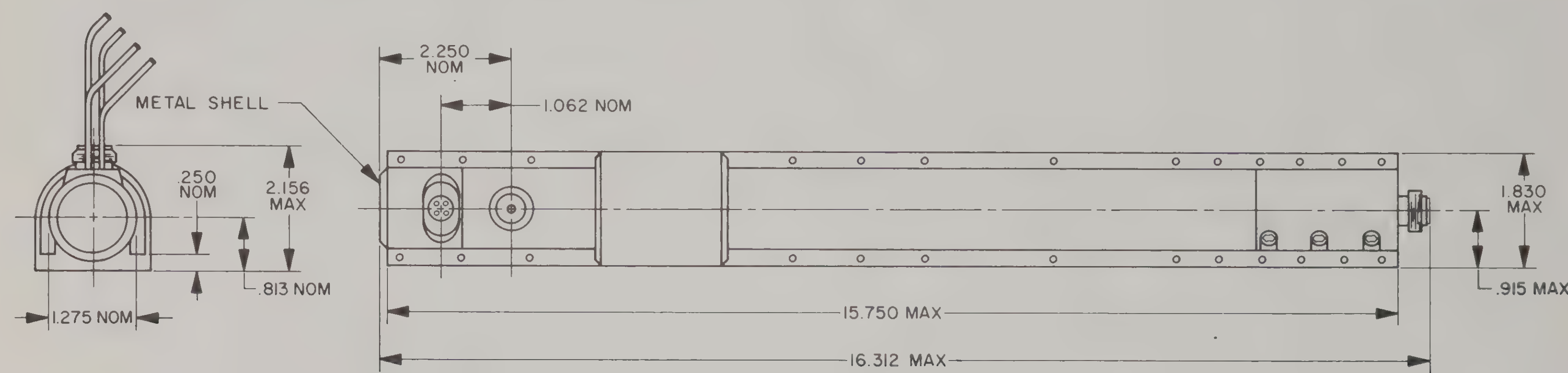


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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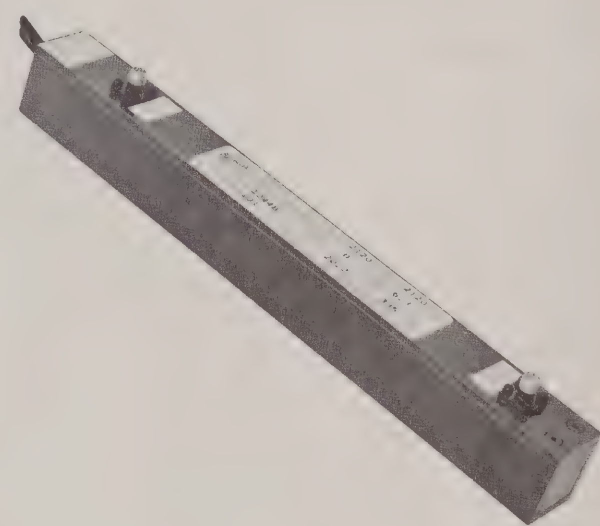
SAN CARLOS
CALIFORNIA

EM-1044B

TRAVELING WAVE TUBE
5.0-11.0 GHz
2 W C.W. Min.
60 dB Min.

The EM1044B TWT is one of a family of light weight, high performance TWTS available from EIMAC. Applications include both airborne and ground based systems subject to stringent environments where reliable, long life performance is of major concern. Typical applications are as ECM drivers, airborne radar, communications, radar augmenters, and special test equipment.



FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	5.0-11.0 GHz
Saturated Power Ouput (Min)	2 W
(Typical)	3 W
Small Signal Gain (Min)	60 dB
(Typical)	65 dB
Saturated Gain (Min)	50 dB
(Typical)	55 dB
Output VSWR (Max)	2.5 : 1
Input VSWR (Max)	2.5 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	28 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

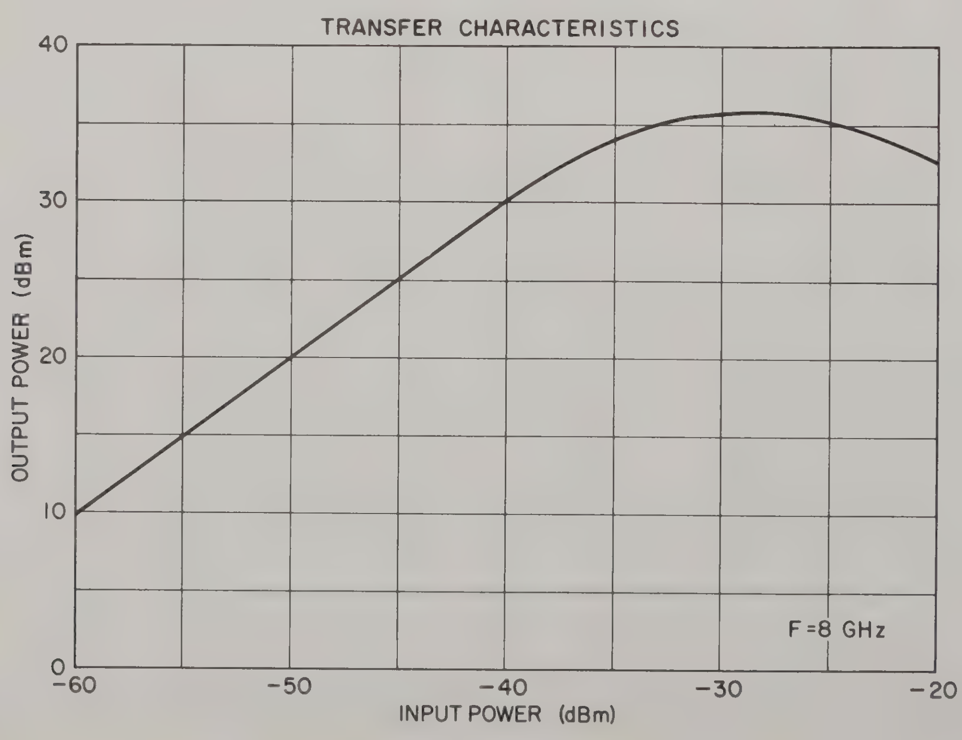
	Min.	Max.	Units
Cathode Voltage	-1800	-2200	V
Cathode Current	15	25	mA
Focus Electrode Voltage	-20	0	V (Ref to Cath)
Focus Electrode Current		100	μA
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.4		A

ENVIRONMENT

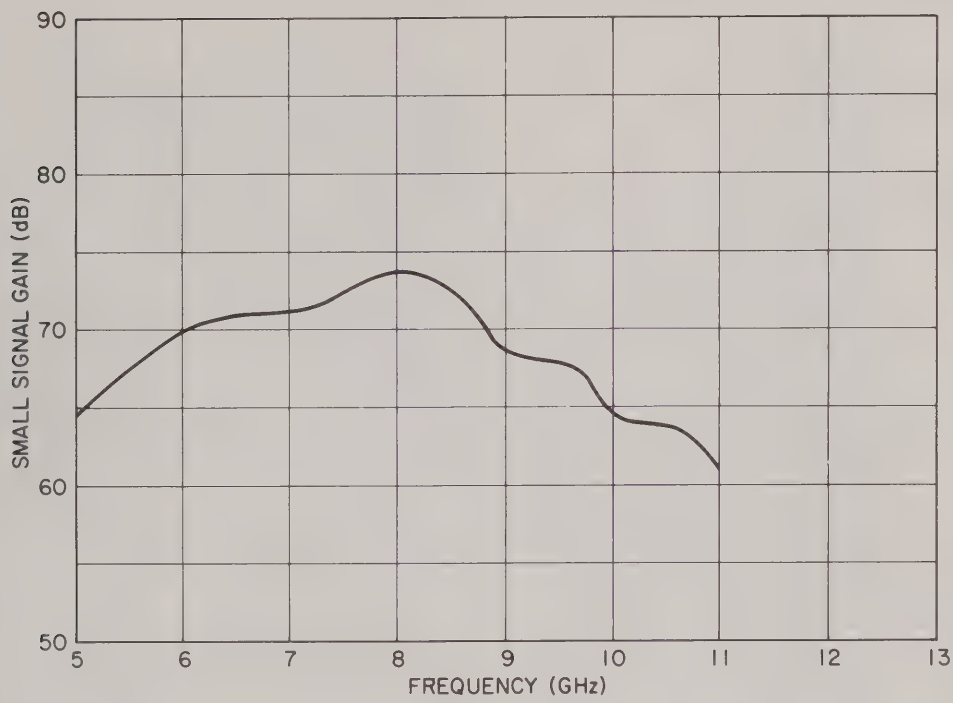
Vibration	15G, 5 to 500 cps
Shock	25G, 11 ms
Acceleration	10G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

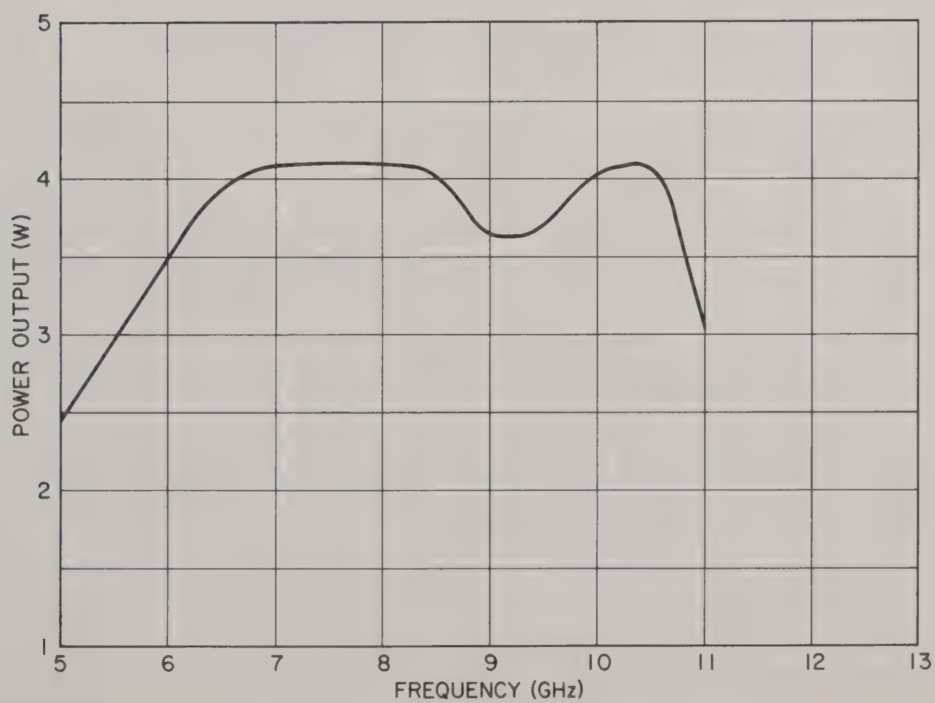
Length	9-3/4 in.
Width	1 in.
Height (excluding RF connectors)	1-1/8 in.
Weight	1-1/4 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	OSM Female
Mounting Position	Any

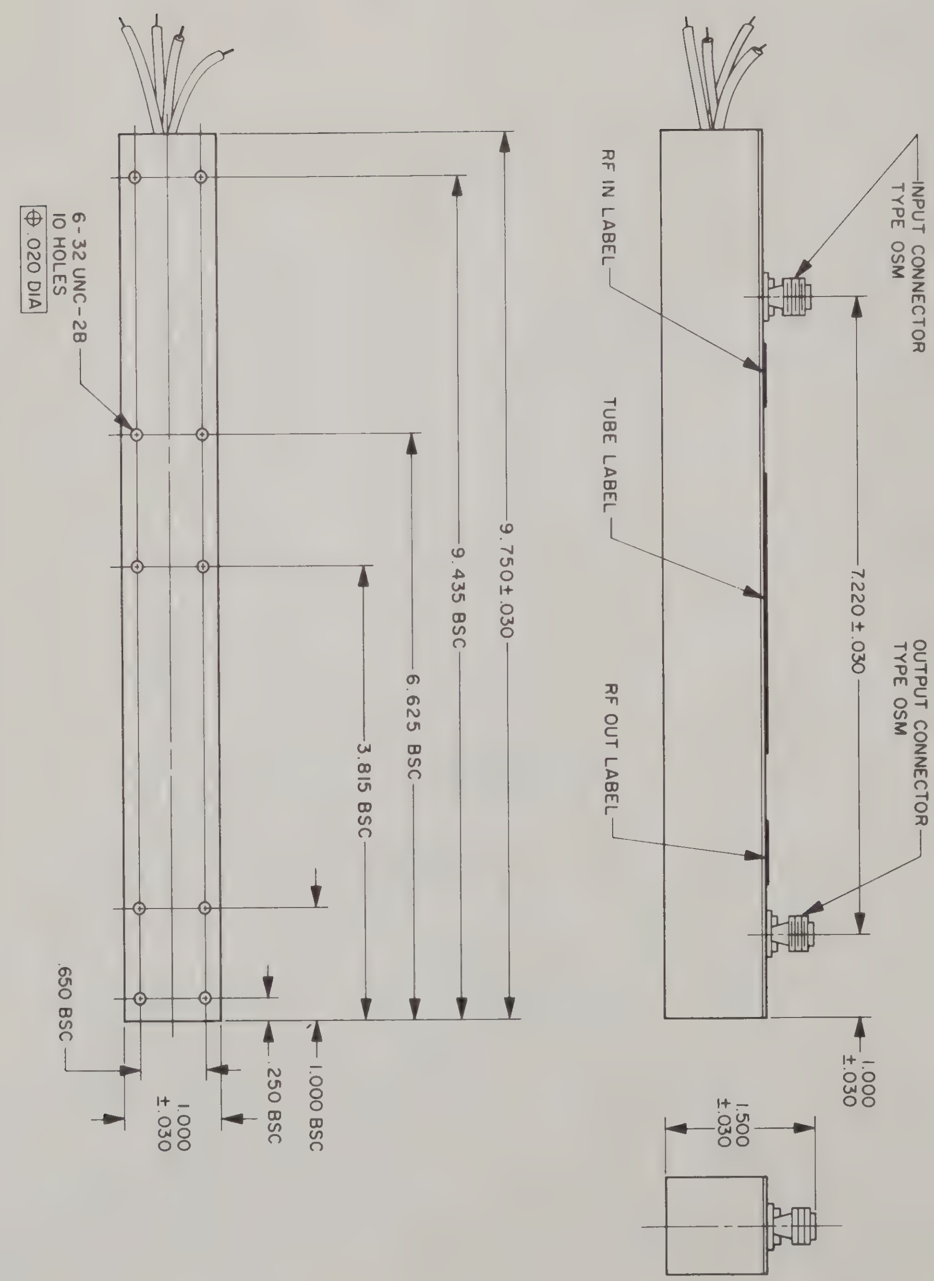


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
GREEN	FOCUS ELECTRODE
BLACK	BODY GROUND

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SAN CARLOS
CALIFORNIA

EM-1045A

TRAVELING WAVE TUBE
8.0-12.0 GHz
1 W C.W. Min.
60 dB Min.

The EM1045A is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude, and temperature. These tubes are focussed by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers or radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	8.0-12.0 GHz
Saturated Power Output (Min)	1 W
(Typical)	2 W
Small Signal Gain (Min)	60 dB
(Typical)	65 dB
Saturated Gain (Min)	55 dB
(Typical)	60 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

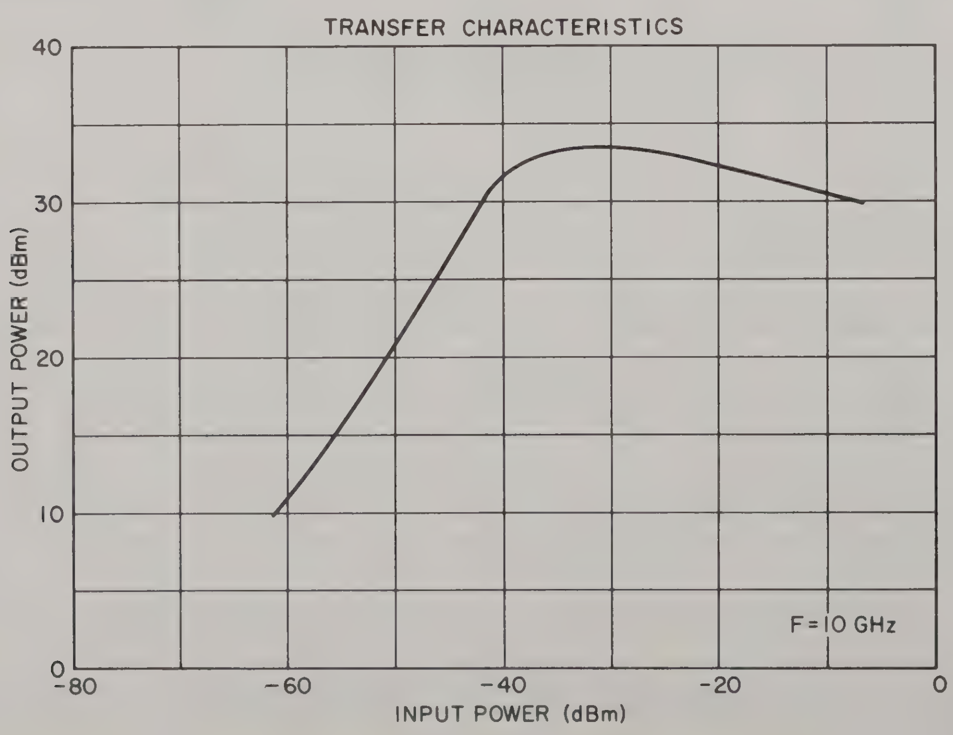
	Min.	Max.	Units
Cathode Voltage	-2800	-3000	V
Cathode Current		25	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	V
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.6		A

ENVIRONMENT

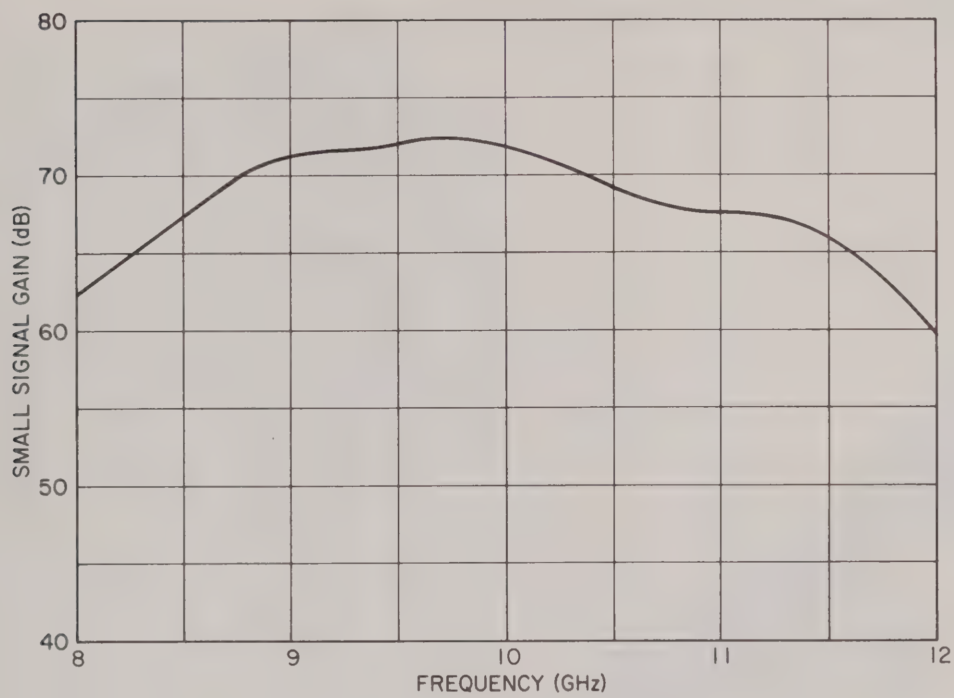
Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

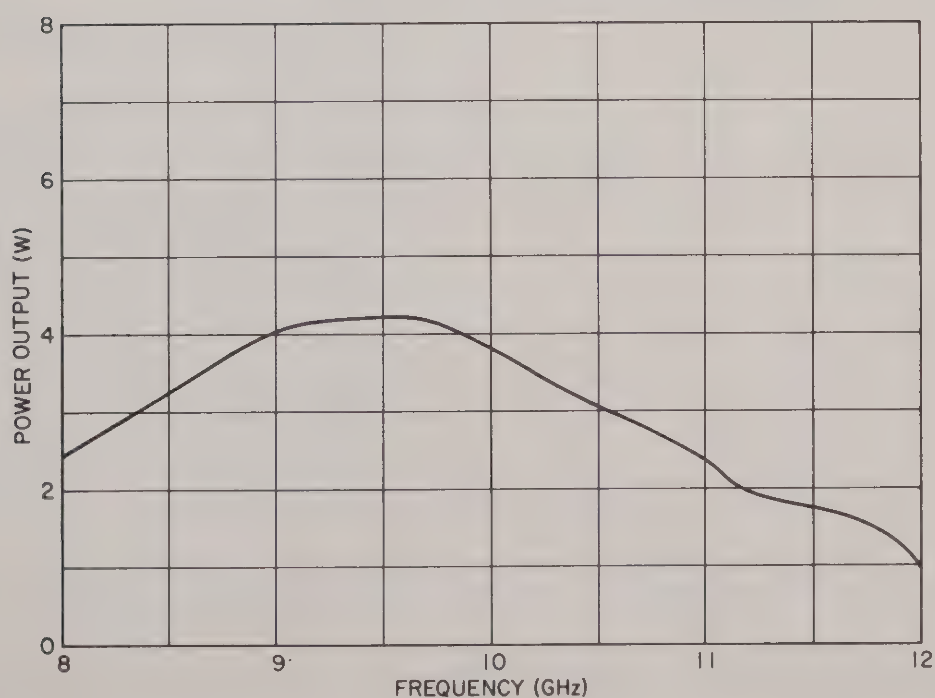
Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4.5 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

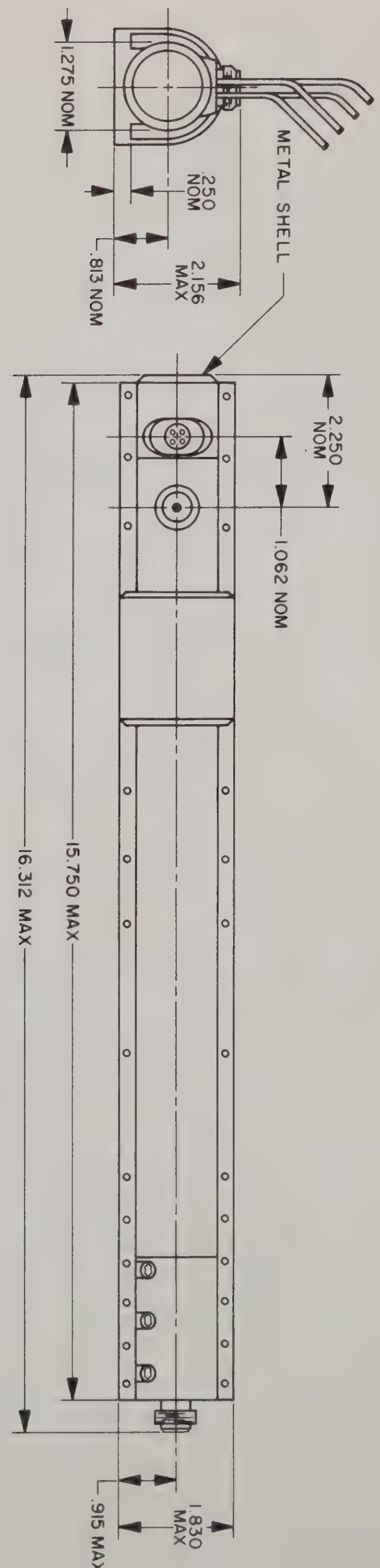


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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EM-1059A

TRAVELING WAVE TUBE
4.0-8.0 GHz
2.0 W C.W. Min.
35 dB Min. S.S.G.

The EM1059A is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude, and temperature. These tubes are focussed by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers and radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	4.0–8.0 GHz
Saturated Power Output (Min)	2.0 W
(Typical)	4.0 W
Small Signal Gain (Min)	35 dB *
(Typical)	36 dB
Saturated Gain (Min)	32 dB *
(Typical)	33 dB
Output VSWR (Max)	2.5 : 1
Input VSWR (Max)	2.5 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

* Improved gain/frequency characteristics can be achieved using equalizers. This detail is available upon request.

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

	Min.	Max.	Units
Cathode Voltage	-2300	-2600	V
Cathode Current		32	mA
Focus Electrode Voltage	0	+10	V (Ref to Cath)
Focus Electrode Current		1	mA
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.45		A

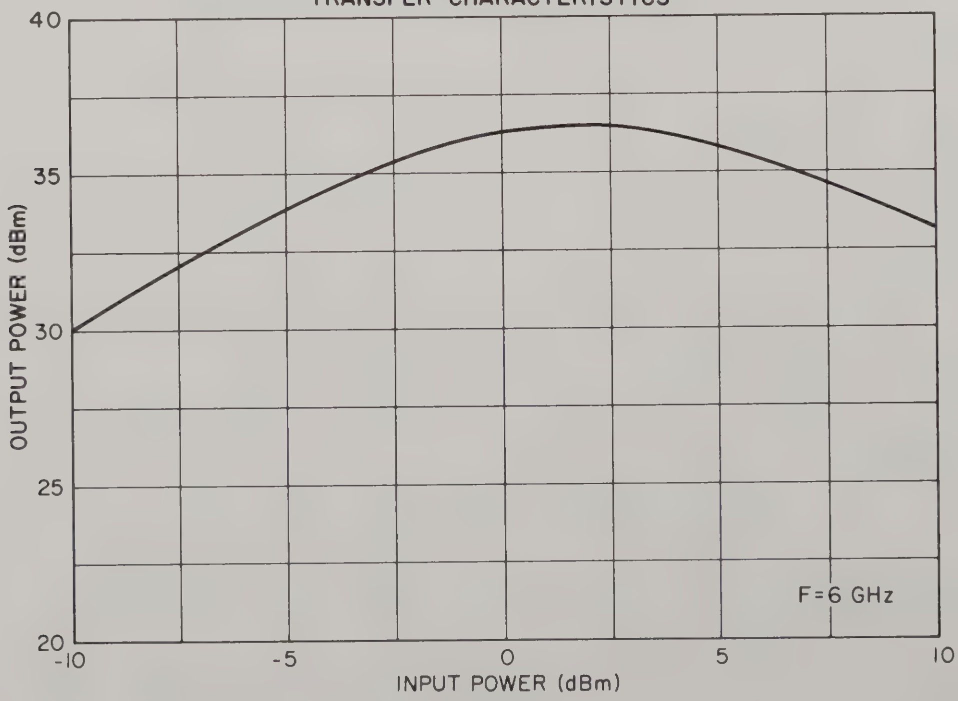
ENVIRONMENT

Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

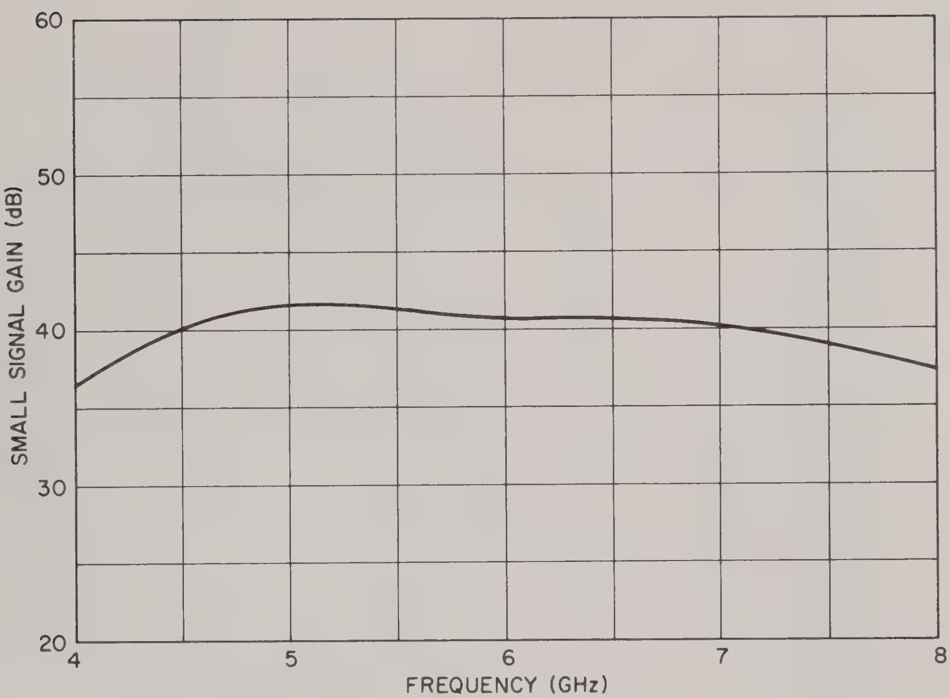
MECHANICAL

Length	14.15 in.
Width	1.78 in.
Height (excluding RF connectors)	2.00 in.
Weight	3.5 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	TNC
Mounting Position	Any

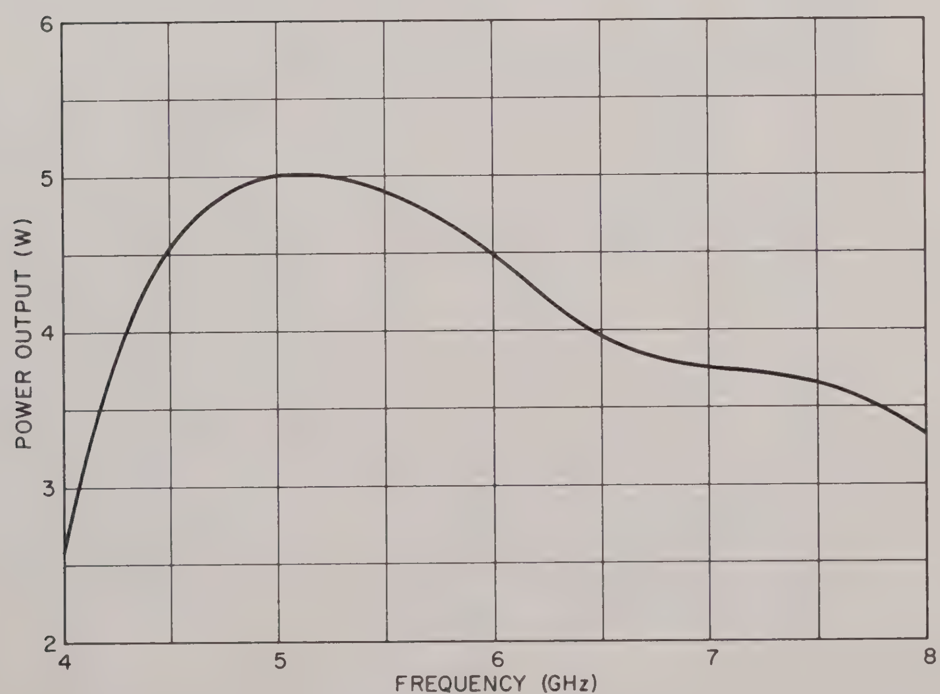
TRANSFER CHARACTERISTICS

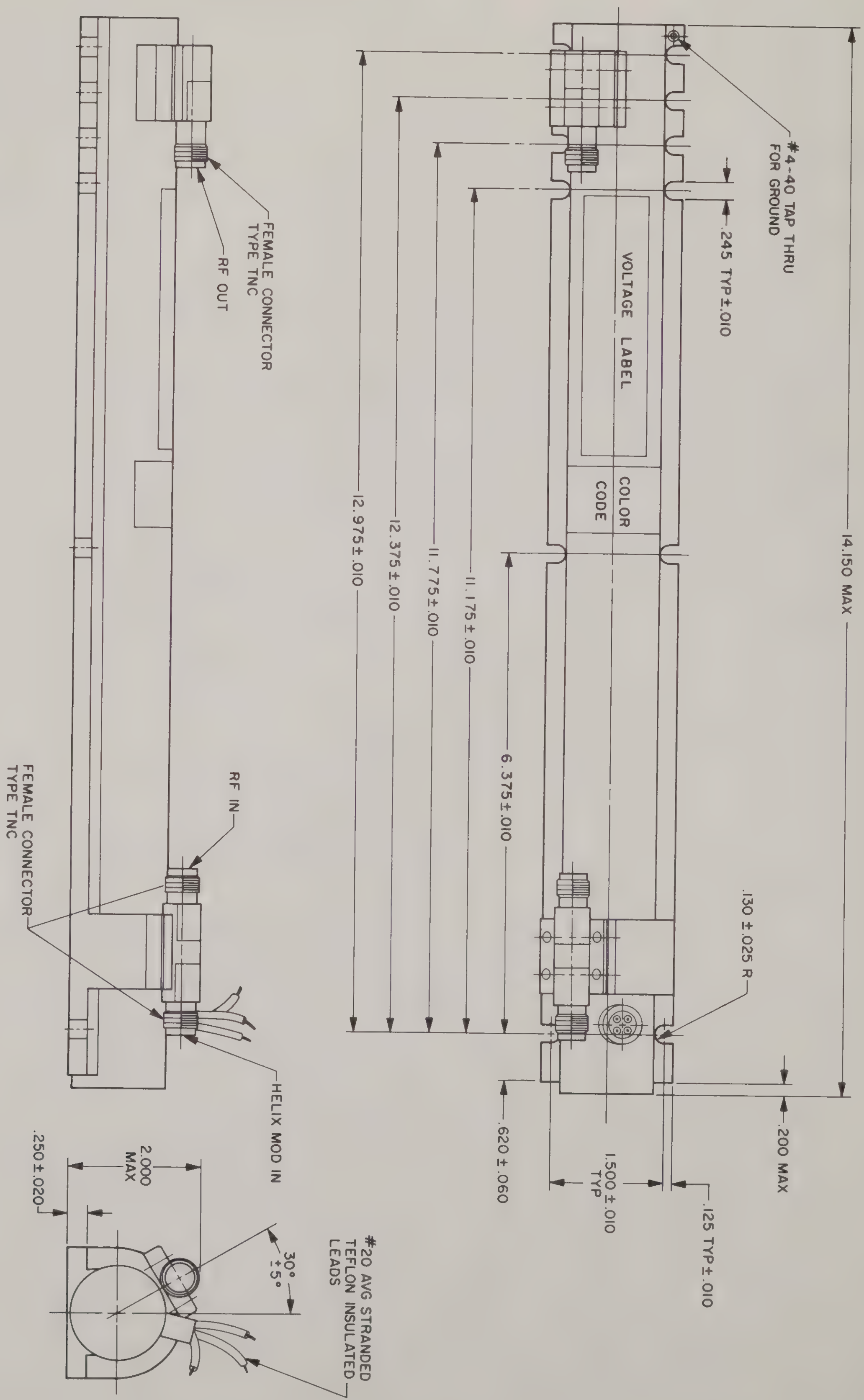


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLUE	ANODE

EM-1060A

TRAVELING WAVE TUBE
2.5-11.0 GHz
0.5 W C.W. Min.
30 dB Min. S.S.G.

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The EM1060A is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock, vibration, altitude, and temperature. These tubes are focussed by a fully temperature compensated periodic permanent magnet array. Typical applications are as ECM drivers and radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	2.5-11.0 GHz
Saturated Power Output (Min)	0.5 W
(Typical)	1 W
Small Signal Gain (Min)	30 dB
(Typical)	35 dB
Saturated Gain (Min)	28 dB
(Typical)	29 dB
Output VSWR (Max)	3.5 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	34 dB
(Typical)	30 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

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ELECTRICAL

	Min.	Max.	Units
Cathode Voltage	-2700	-3000	V
Cathode Current		25	mA
Focus Electrode Voltage	-50	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.6		A

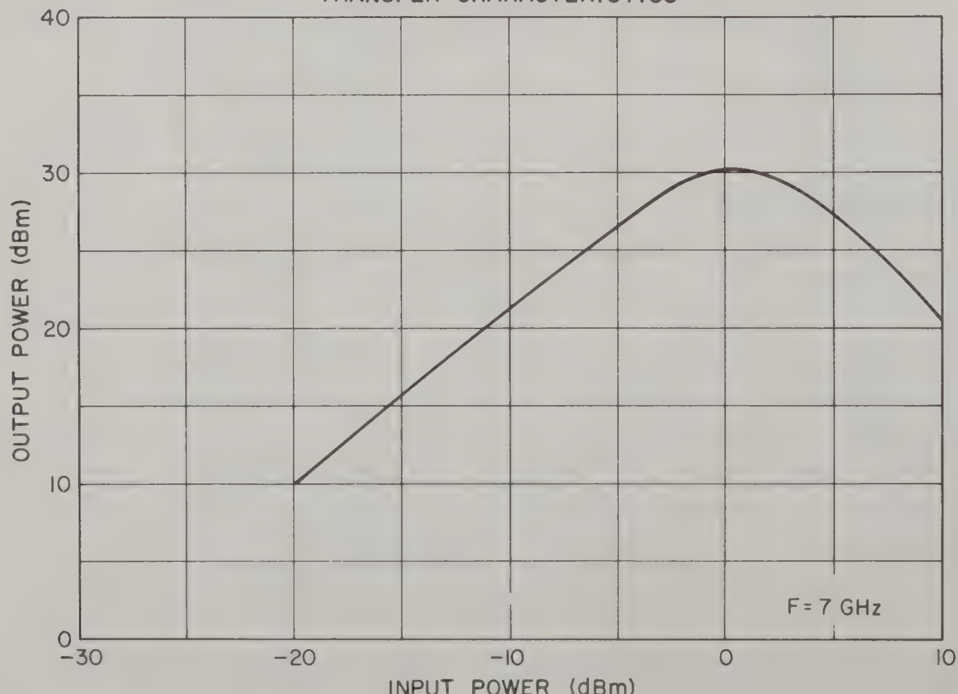
ENVIRONMENT

Vibration	10G, to 2000 cps
Shock	25G, 11 ms
Acceleration	25G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

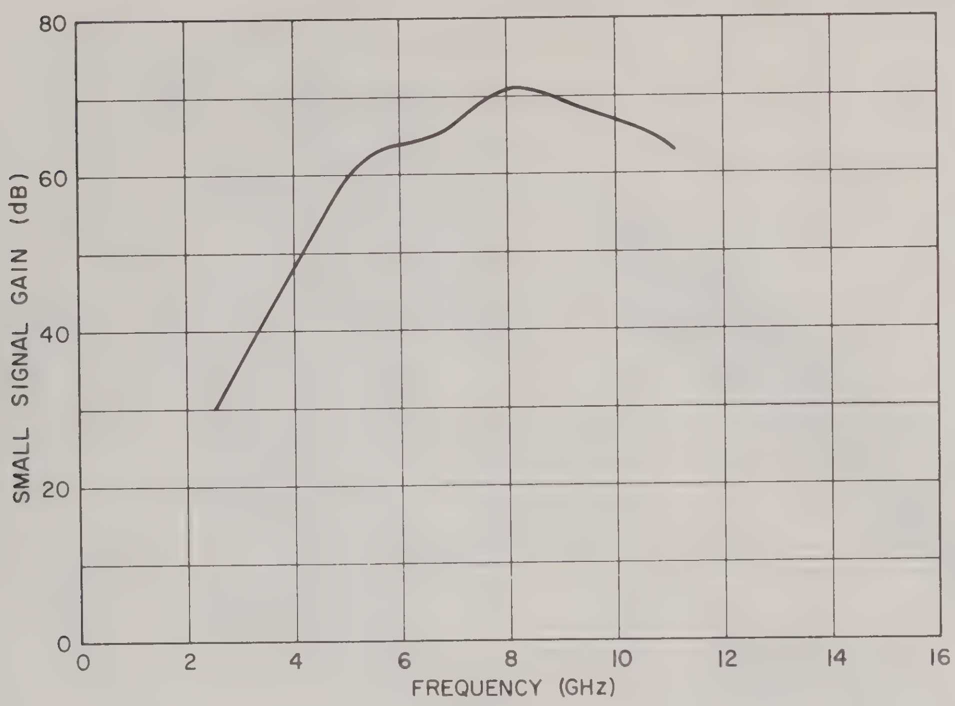
MECHANICAL

Length	16-5/16 in.
Width	1.830 in.
Height (excluding RF connectors)	2.156 in.
Weight	4.5 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	Type "N" Female
Mounting Position	Any

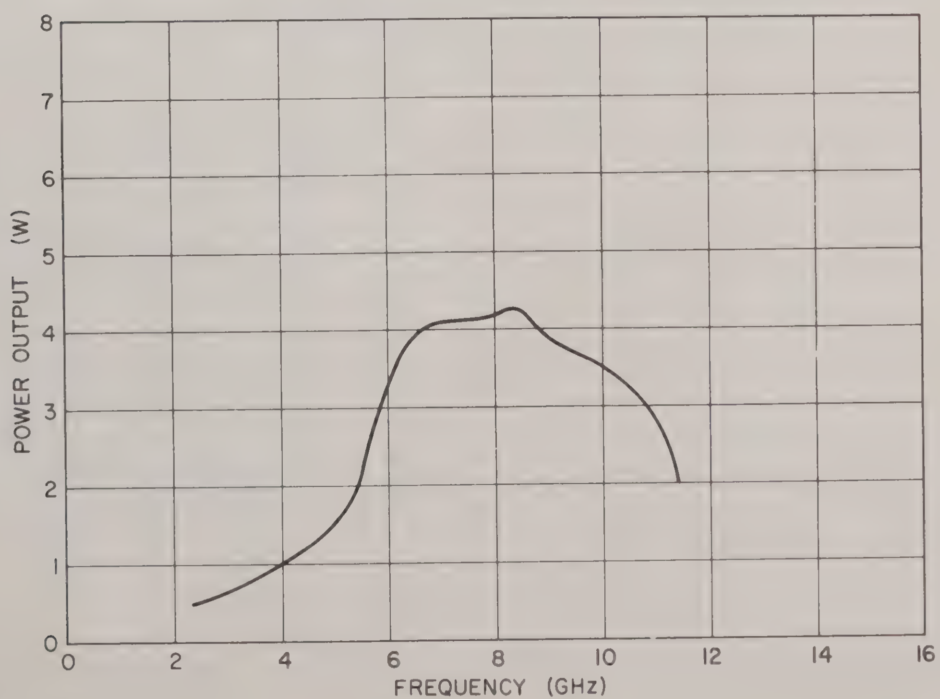
TRANSFER CHARACTERISTICS

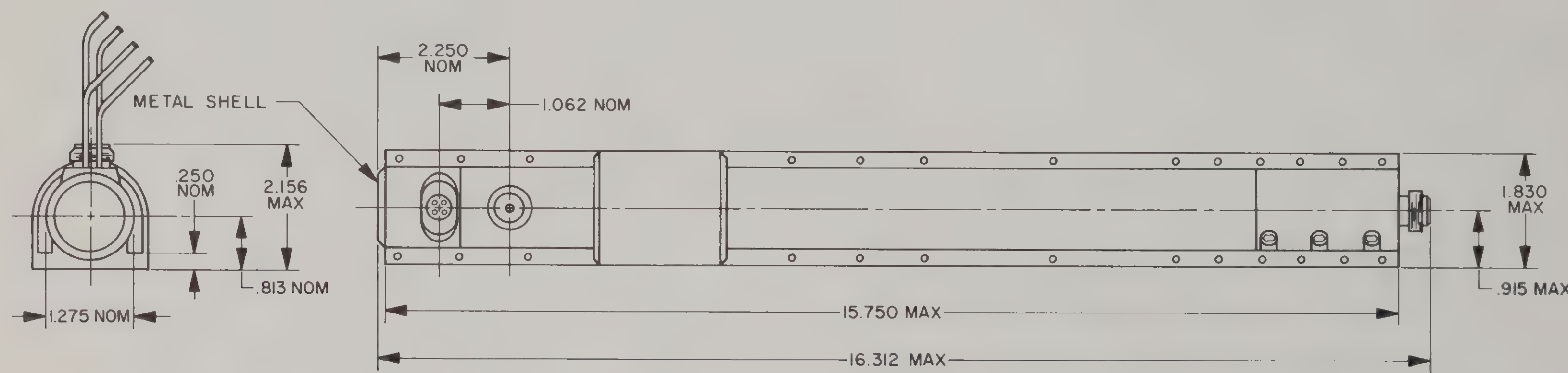


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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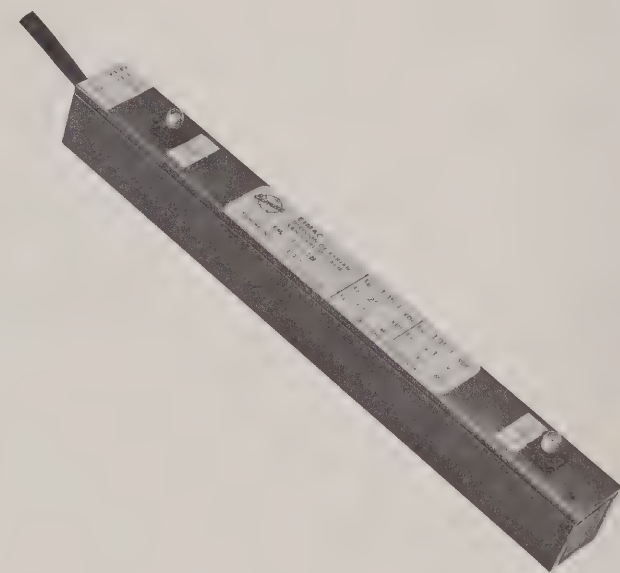
EM-1061B

TRAVELING WAVE TUBE
2.0-4.0 GHz
2 W C.W. Min.
40 dB Min. S.S.G.

The EM1061B TWT is one of a family of light weight, high performance TWTS available from EIMAC. Applications include both airborne and ground based systems subject to stringent environments where reliable, long life performance is of major concern. Typical applications are as E C M drivers, airborne radar, communications, radar augmenters, and special test equipment.



FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	2.0–4.0 GHz
Saturated Power Output (Min)	2 W
(Typical)	3 W
Small Signal Gain (Min)	40 dB
(Typical)	45 dB
Saturated Gain (Min)	35 dB
(Typical)	40 dB
Output VSWR (Max)	2.5:1
Input VSWR (Max)	2.5:1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	25 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

	Min.	Max.	Units
Cathode Voltage	-900	-1200	V
Cathode Current	25	40	mA
Grid Voltage	15	30	V (Ref to Cath)
Grid Current		8	mA
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.5		A

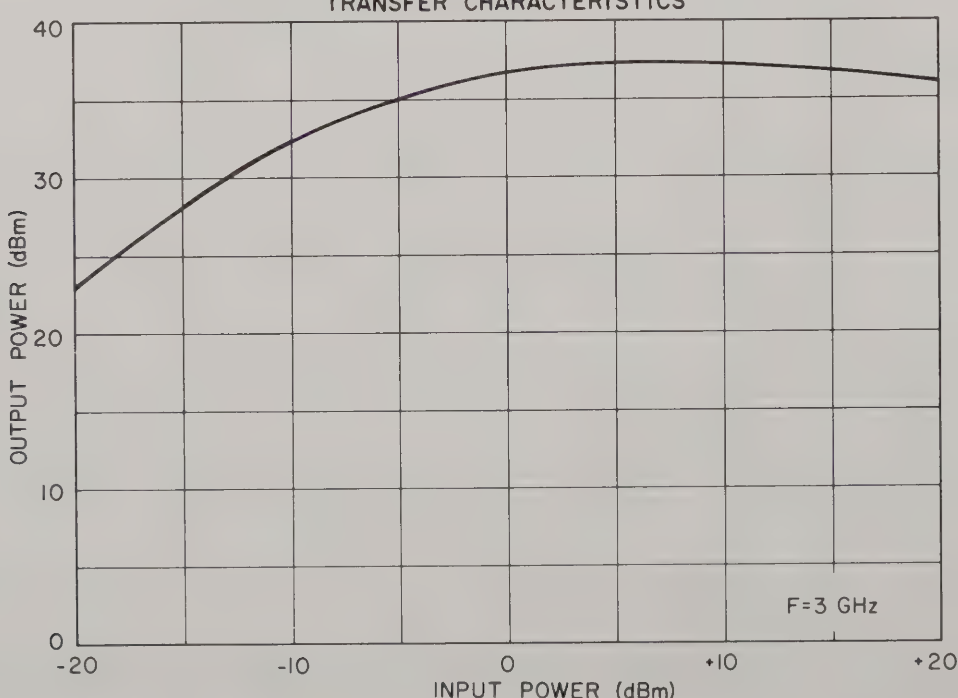
ENVIRONMENT

Vibration	15G, 5 to 500 cps
Shock	25G, 11 ms
Acceleration	10G sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft.

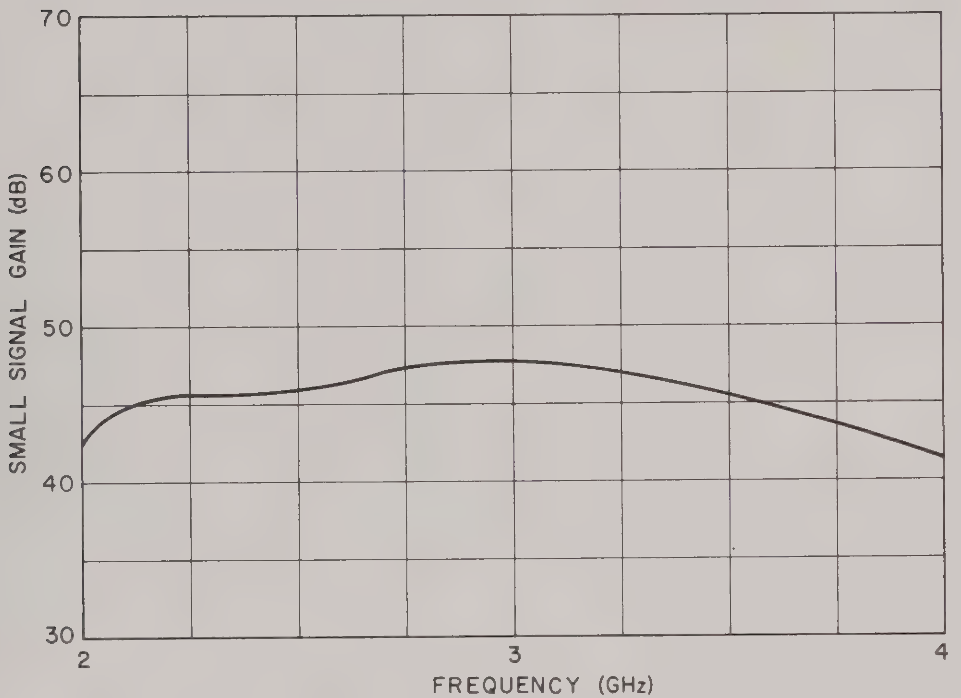
MECHANICAL

Length	8-3/4 in.
Width	1 in.
Height (excluding RF connectors)	1-1/8 in.
Weight	1-1/4 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	OSM Female
Mounting Position	Any

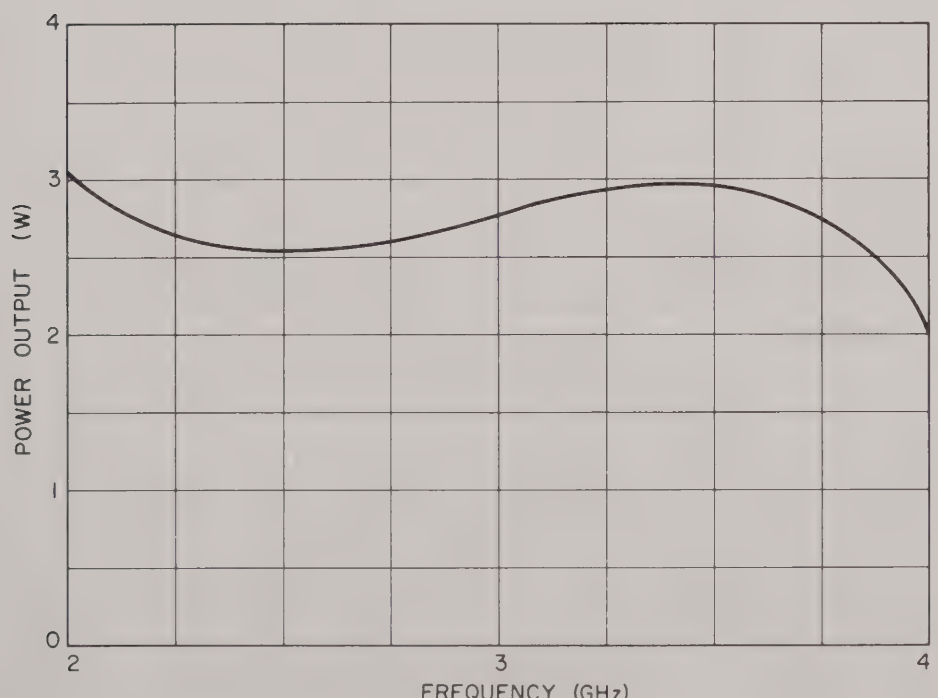
TRANSFER CHARACTERISTICS

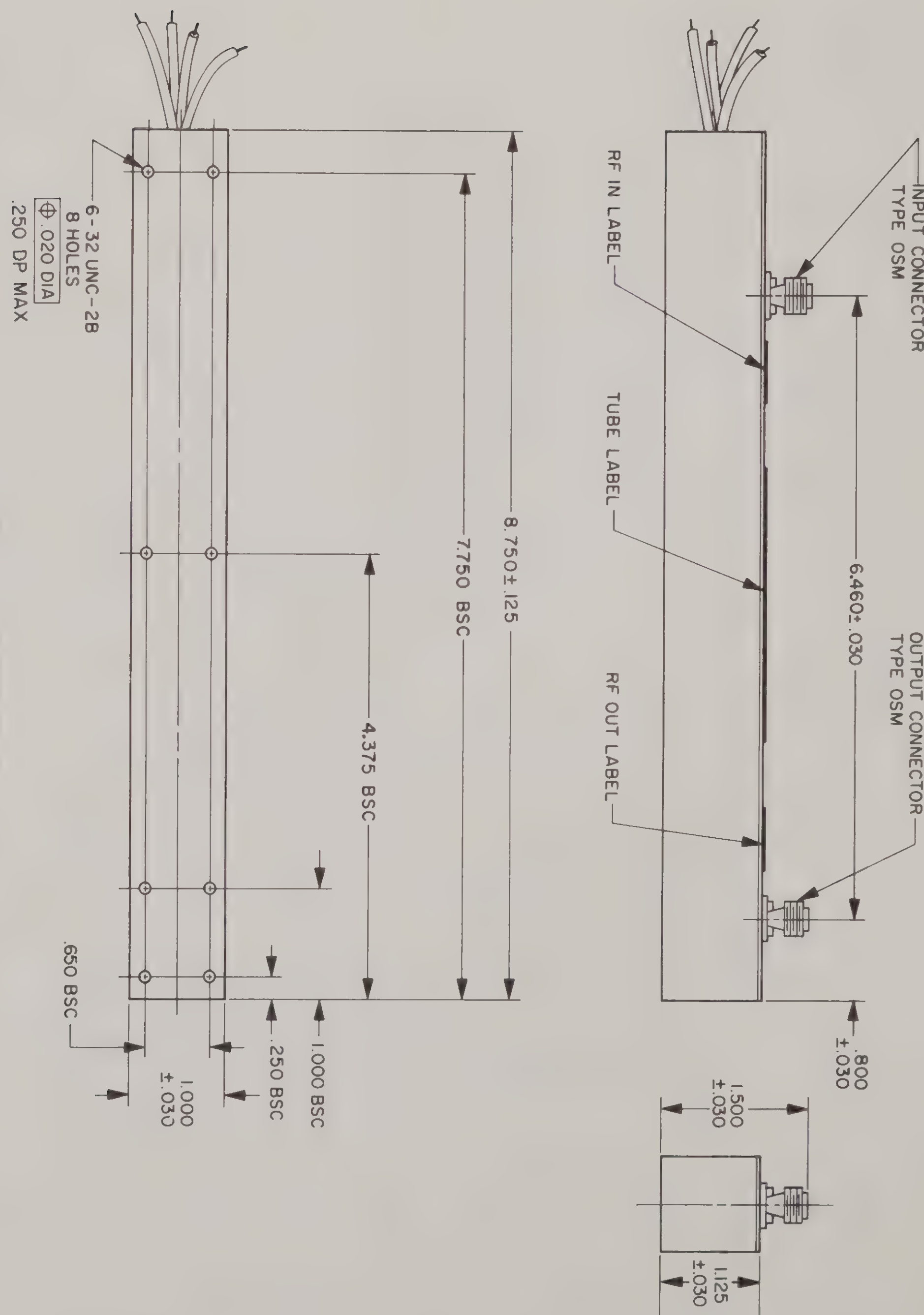


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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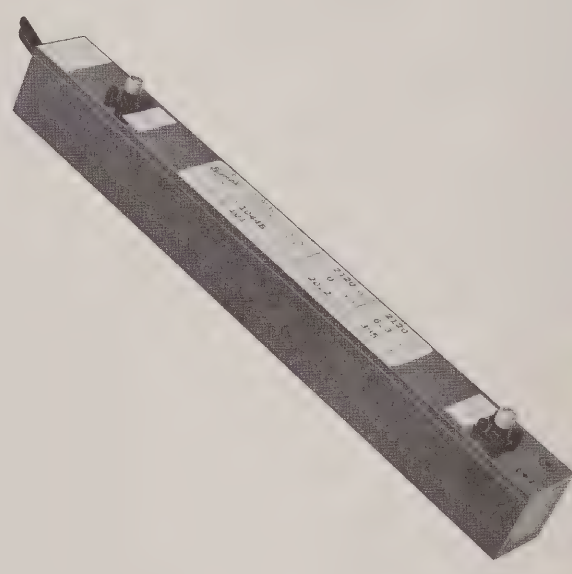
EM-1061D

TRAVELING WAVE TUBE
2.0-4.0 GHz
5 W C.W. Min.
50dB Min. S.S.G.

The EM1061D TWT is one of a family of light weight, high performance TWTS available from EIMAC. Applications include both airborne and ground based systems subject to stringent environments where reliable, long life performance is of major concern. Typical applications include ECM airborne radar, communications, radar augmenters, and special test equipment.



FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	2.0-4.0 GHz
Saturated Power Output (Min)	5 W
(Typical)	6 W
Small Signal Gain (Min)	50 dB
(Typical)	55 dB
Saturated Gain (Min)	44 dB
(Typical)	49 dB
Output VSWR (Max)	2.5:1
Input VSWR (Max)	2.5:1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	27 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

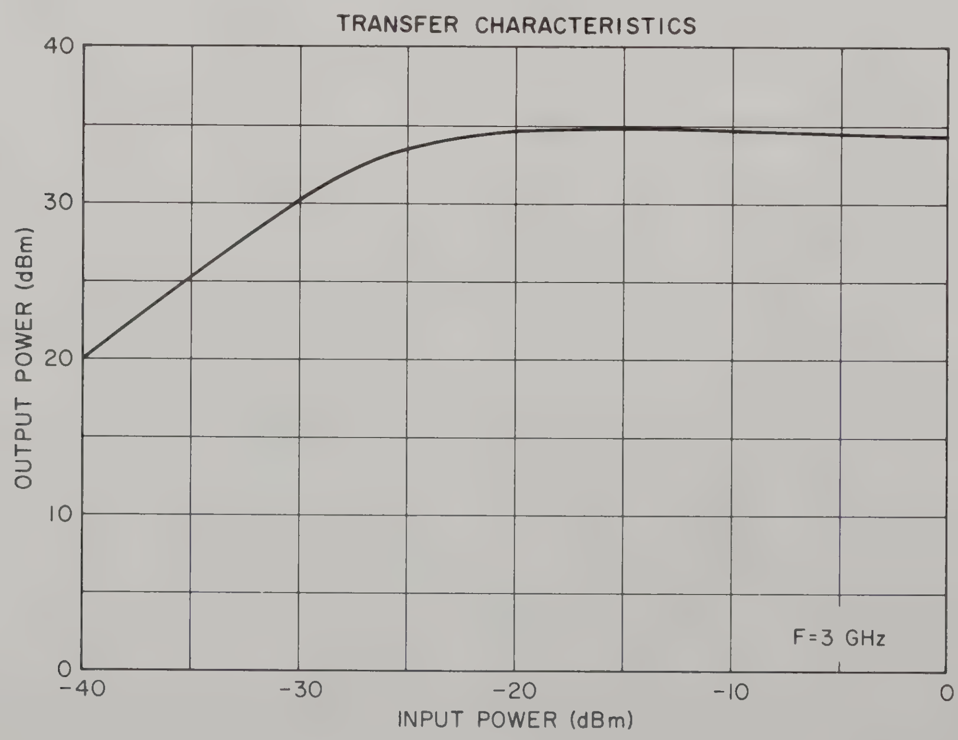
	Min.	Max.	Units
Cathode Voltage	-900	-1200	V
Cathode Current	50	65	mA
Grid Voltage	10	30	V (Ref to Cath)
Grid Current		8.0	mA
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.5		A

ENVIRONMENT

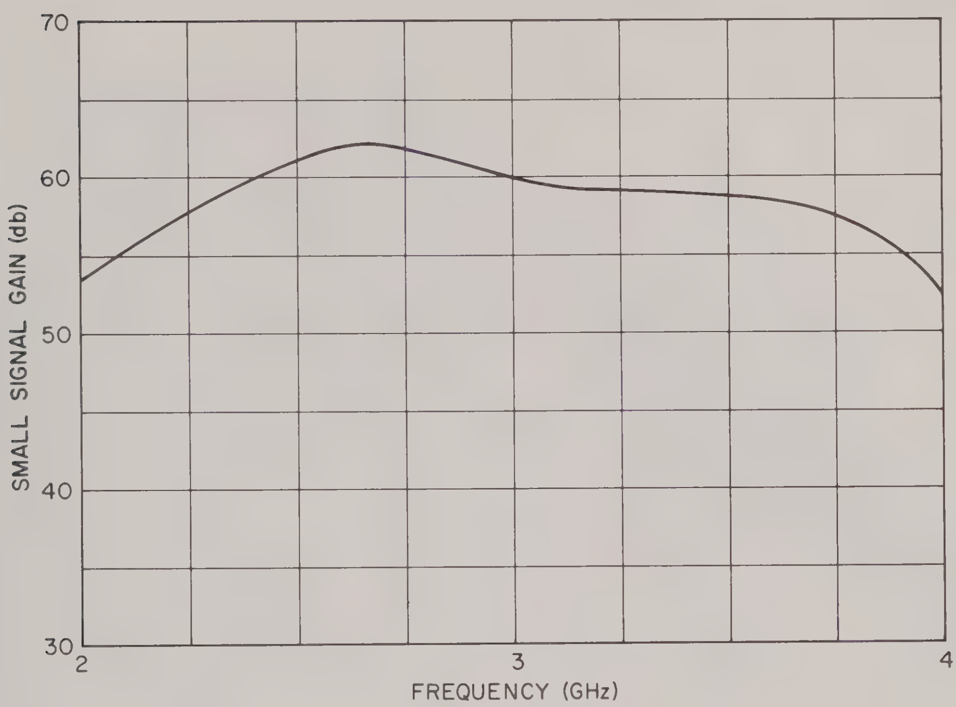
Vibration	15G, 5 to 500 cps
Shock	25G, 11 ms
Acceleration	10G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

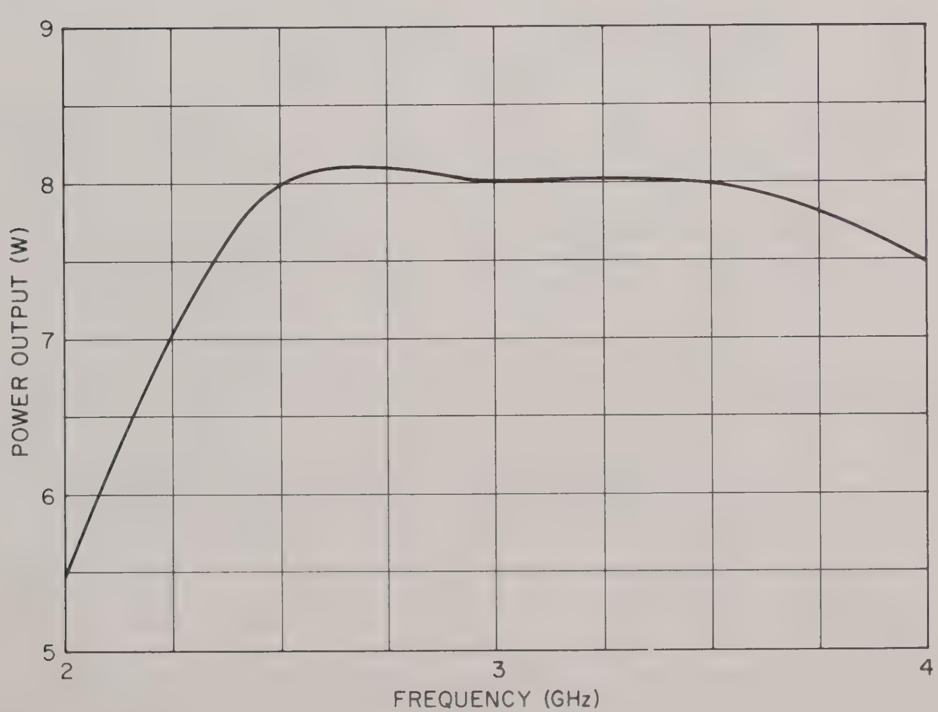
Length	8-3/4 in.
Width	1 in.
Height (excluding RF connectors)	1-1/8 in.
Weight	1-1/4 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	OSM Female
Mounting Position	Any

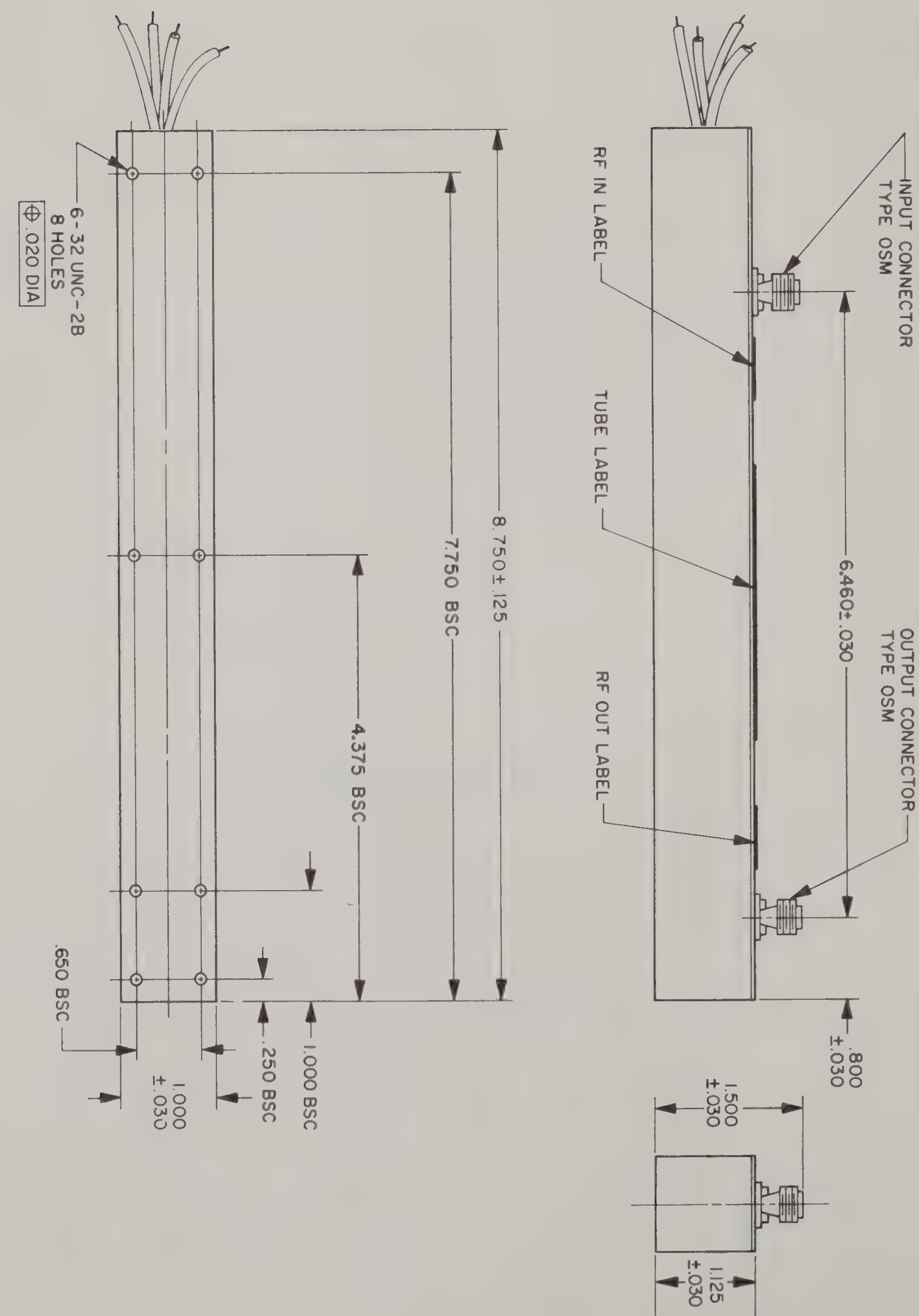


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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EM-1167A

TRAVELING WAVE TUBE

4.0-8.0 GHz

1 W C.W. Min.

30 dB Min. S.S.G.

The EM1167A TWT is one of a family of light weight, high performance TWTS available from EIMAC. Applications include both airborne and ground based systems subject to stringent environments where reliable, long life performance is of major concern. Typical applications are as ECM drivers and radar augmenters, and in airborne radar, communications, and special test equipment.

FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	4.0-8.0 GHz
Saturated Power Output (Min)	1 W
(Typical)	1.5 W
Small Signal Gain (Min)	30 dB
(Typical)	35 dB
Saturated Gain (Min)	24 dB
(Typical)	29 dB
Output VSWR (Max)	2.5 : 1
Input VSWR (Max)	2.5 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	27 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

	Min.	Max.	Units
Cathode Voltage	-1400	-1600	V
Cathode Current	12	20	mA
Focus Electrode Voltage	-10	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.5		A

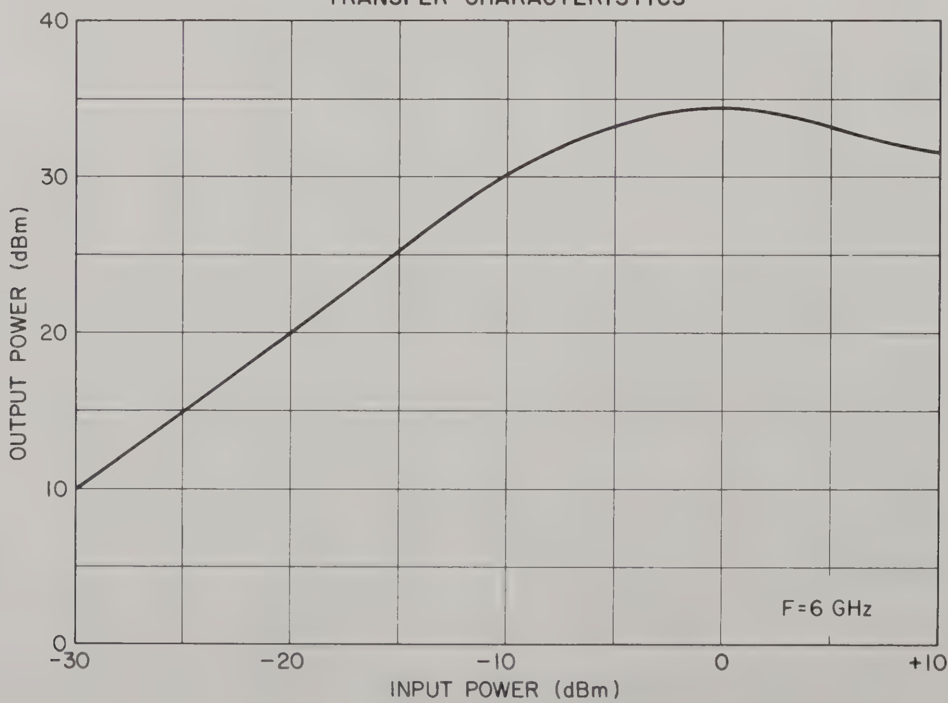
ENVIRONMENT

Vibration	15G, 5 to 500 cps
Shock	25G, 11 ms
Acceleration	10G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

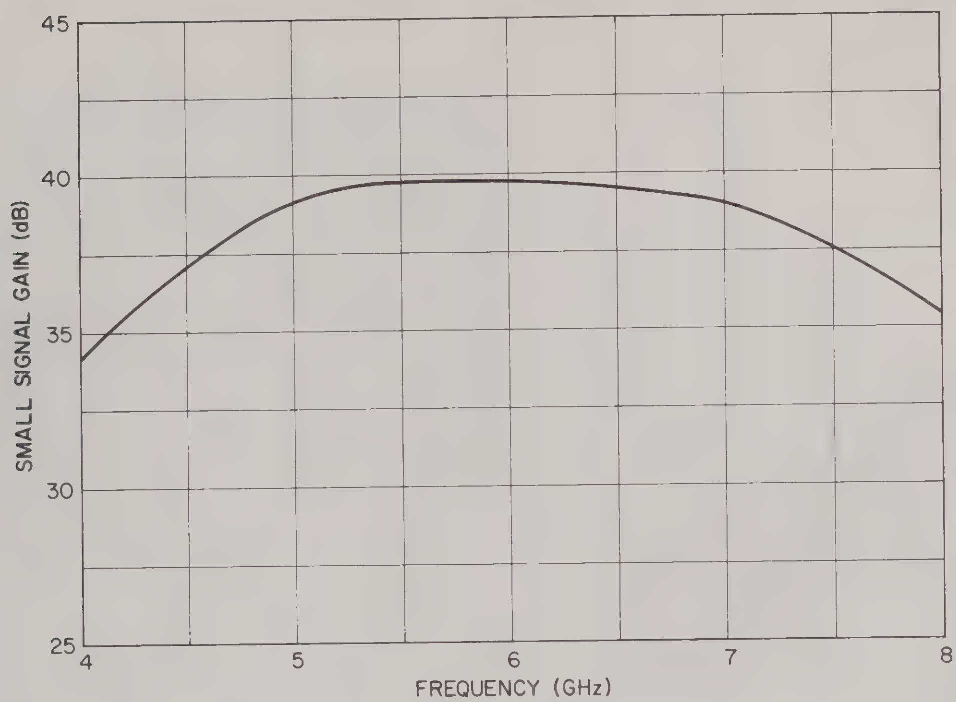
MECHANICAL

Length	7-3/4 in.
Width	1 in.
Height (excluding RF connectors)	1-1/8 in.
Weight	1 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	OSM Female
Mounting Position	Any

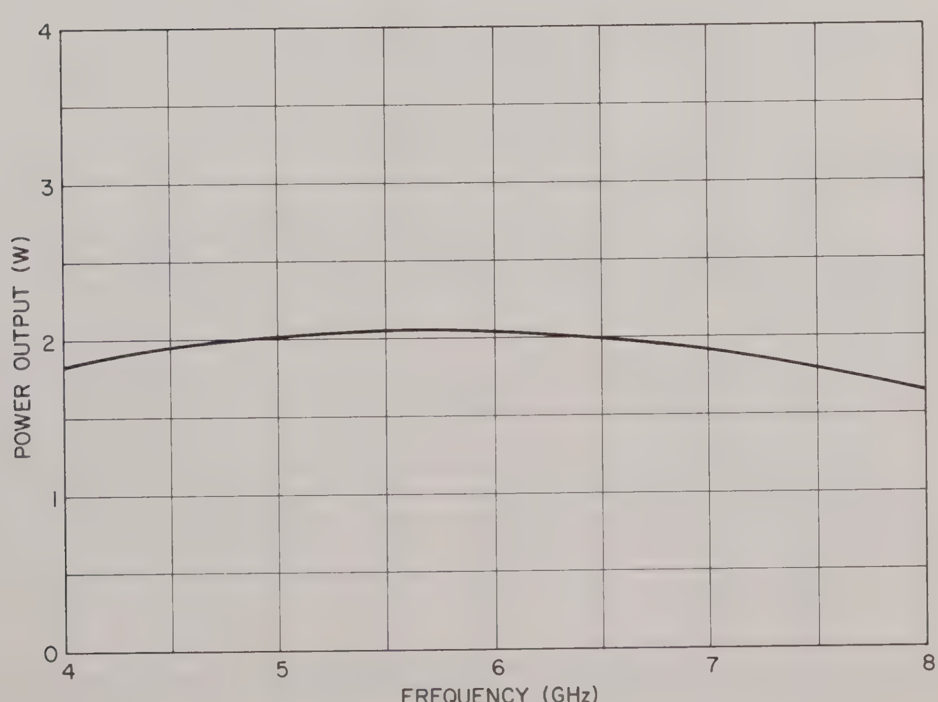
TRANSFER CHARACTERISTICS

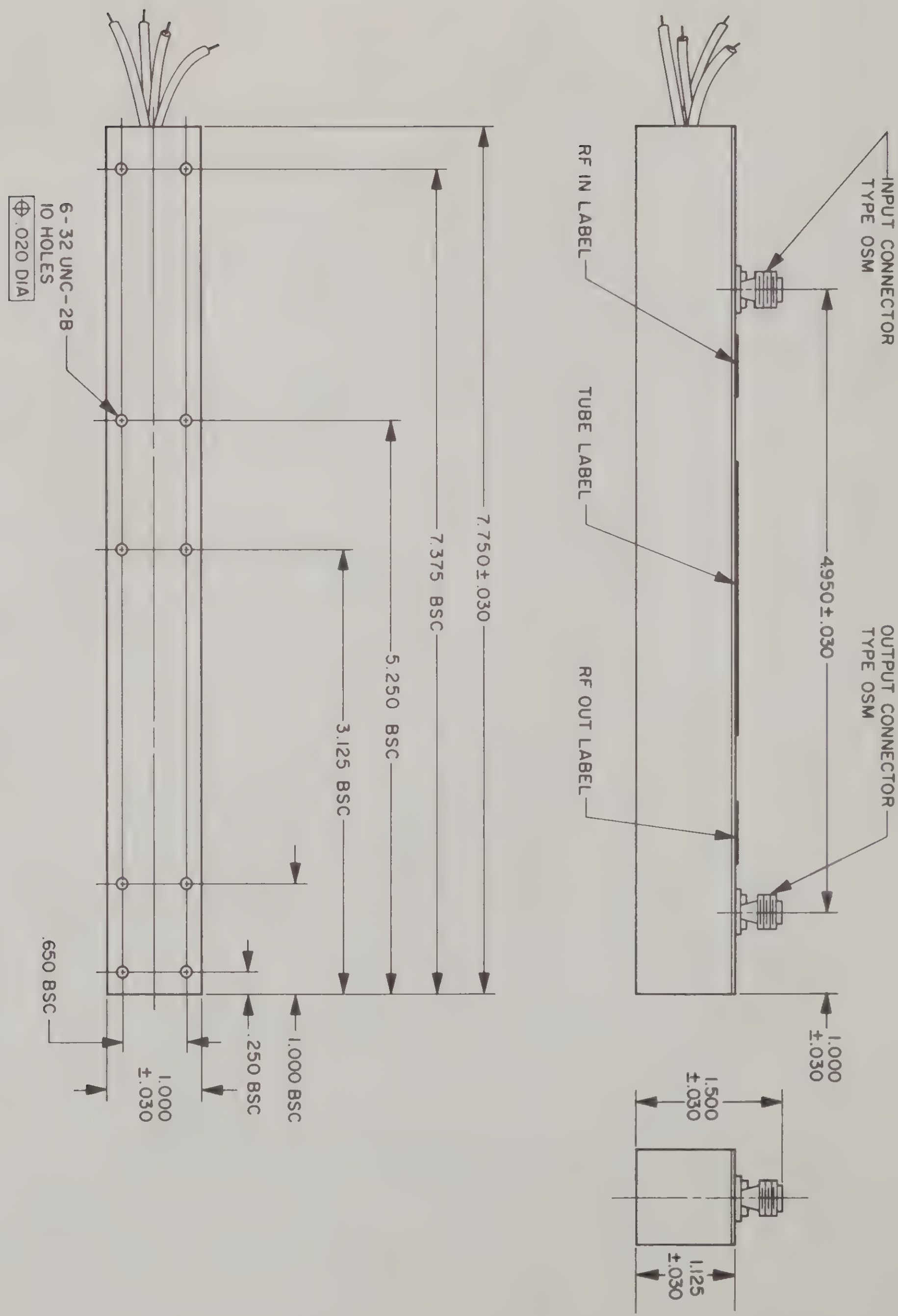


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
GREEN	FOCUS ELECTRODE
BLACK	BODY GROUND

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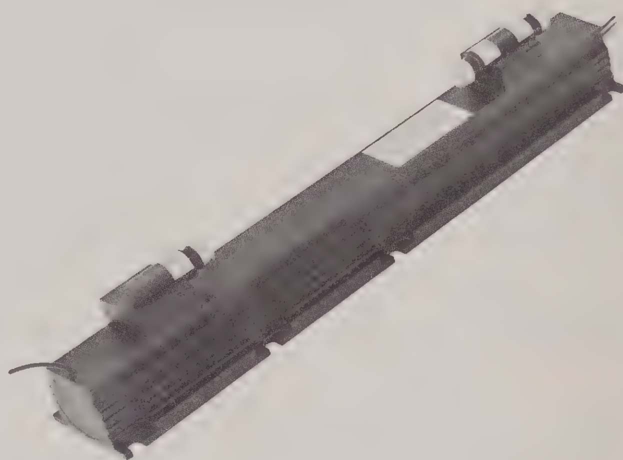
EM-1199

TRAVELING WAVE TUBE
4.0-8.0 GHz
10 W C.W. Min.
50 dB Min.

The EM1199 is one of a family of ruggedized ceramic and metal traveling wave tubes designed to work under severe environmental extremes of shock vibration, altitude, and temperature. These tubes are focussed by a temperature insensitive periodic permanent magnet array. The helix connection is separately brought out from the envelope to facilitate serrodyne operation. Typical applications include use as ECM drivers and radar augmenters, and in airborne radar, communications, and special test equipment.



FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	4.0-8.0 GHz
Saturated Power Output (Min)	10 W
(Typical)	15 W
Small Signal Gain (Min)	50 dB
(Typical)	55 dB
Saturated Gain (Min)	43 dB
(Typical)	48 dB
Output VSWR (Max)	3.0 : 1
Input VSWR (Max)	3.0 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	25 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

ELECTRICAL

	Min.	Max.	Units
Cathode Voltage	-2600	-2900	V
Cathode Current		75	mA
Focus Electrode Voltage	Tied to Cathode		
Focus Electrode Current			
Helix Voltage	Externally Grounded		
Collector Voltage	-1000	0	V
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.5		A

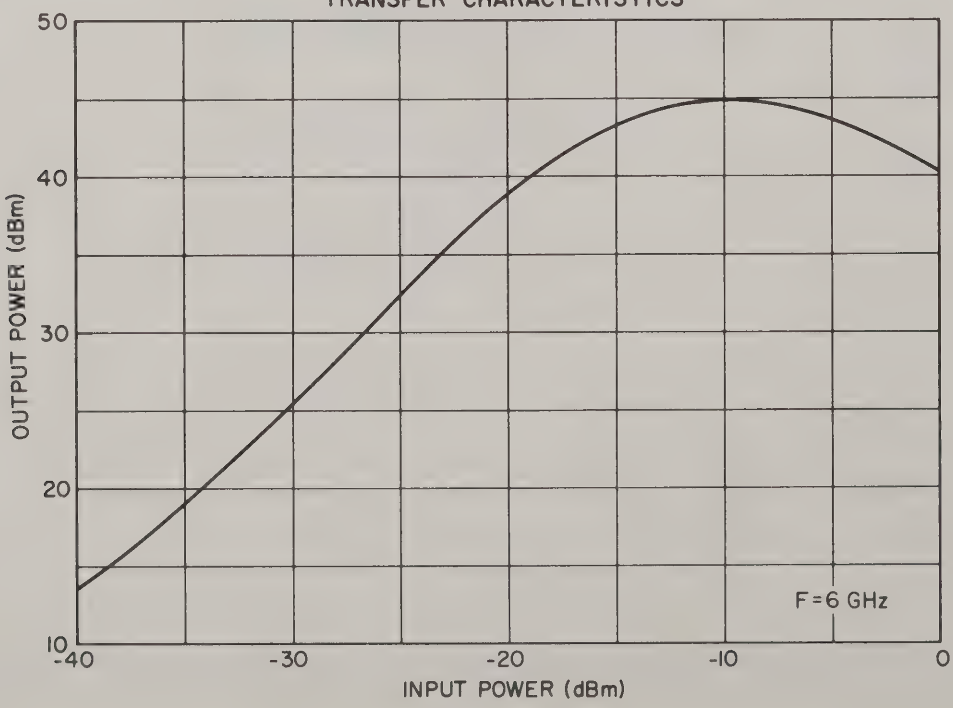
ENVIRONMENT

Vibration	10G, 5 to 500 cps
Shock	15G, 11 ms
Acceleration	10G, sustained
Temperature	-54°C to 110°C
Altitude (unpressurized)	to 70,000 ft

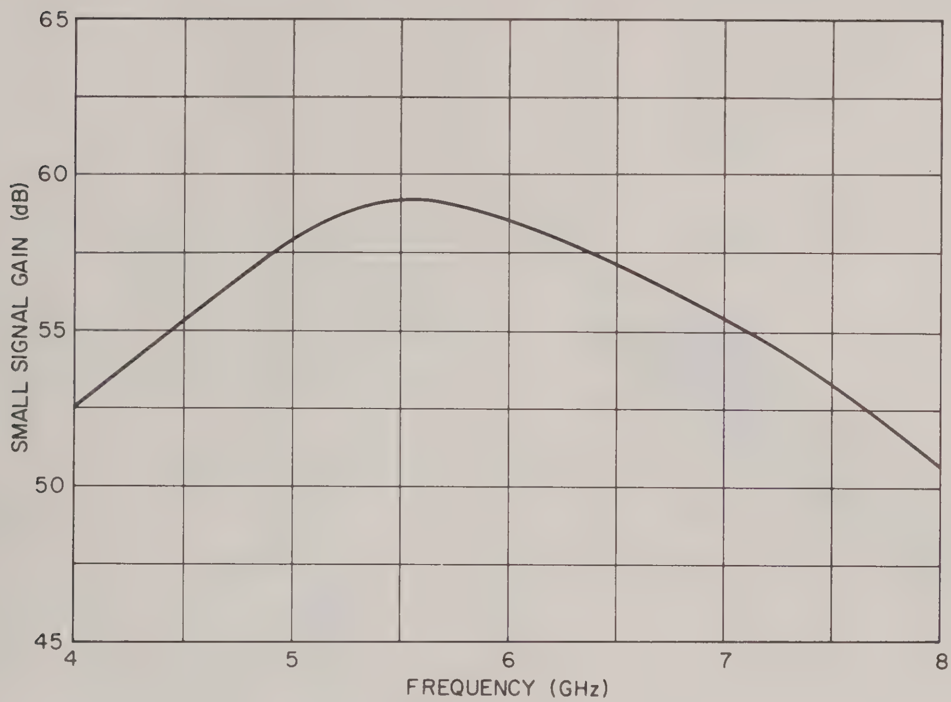
MECHANICAL

Length	11-3/4 in.
Width	1-3/4 in.
Height (excluding RF connectors)	1-1/4 in.
Weight	3 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	TNC
Mounting Position	Any

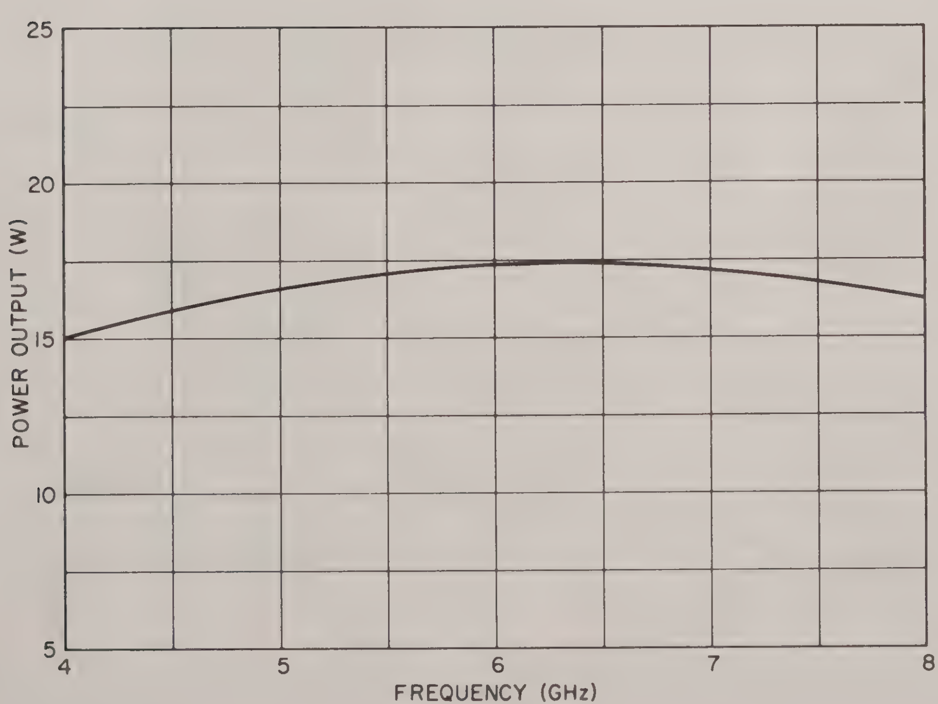
TRANSFER CHARACTERISTICS

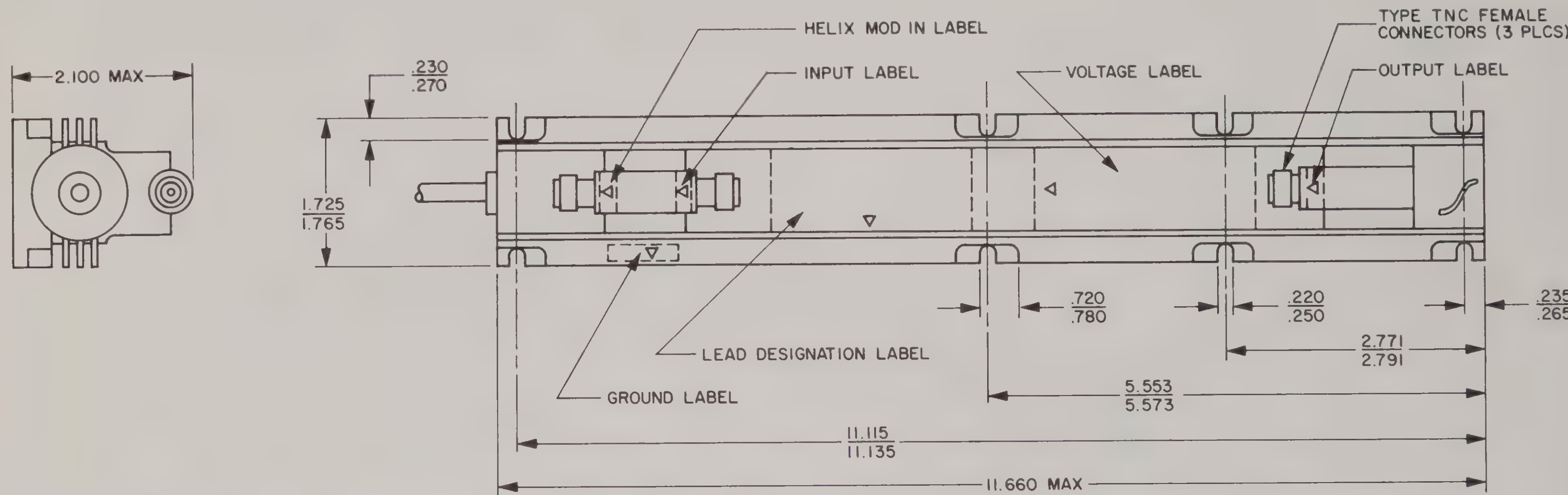


GAIN CHARACTERISTICS

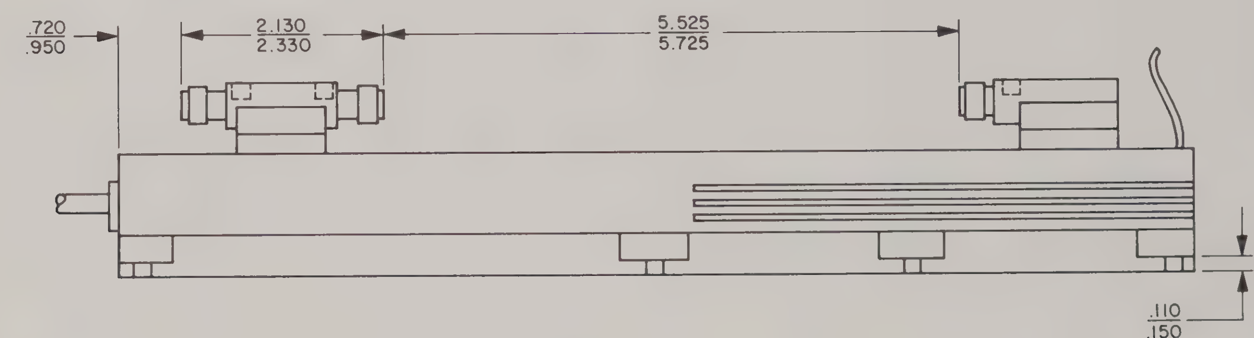


POWER OUTPUT CHARACTERISTICS





CONNECTIONS	
RED	COLLECTOR
PIN A	ANODE
PIN D	HEATER
PIN C	HEATER CATHODE



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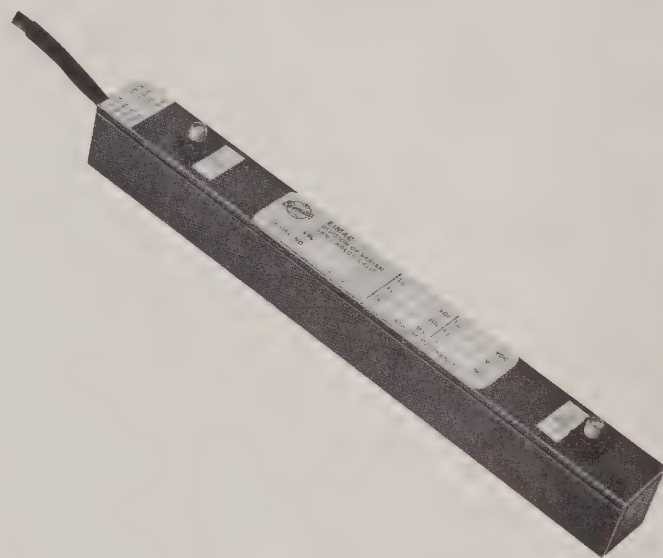
S A N C A R L O S
C A L I F O R N I A

EM-1601A

TRAVELING WAVE TUBE
1.0-4.0 GHz
1 W C.W. Min.
30 dB Min. S.S.G.

The EM1601A TWT is one of a family of light weight, high performance TWTS available from EIMAC. Applications include both airborne and ground based systems subject to stringent environments where reliable, long life performance is of major concern. Typical applications are as ECM drivers and radar augmenters, and in airborne radar, communications, and special test equipment.



FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	1.0-4.0 GHz
Saturated Power Output (Min)	1 W
(Typical)	1.5 W
Small Signal Gain (Min)	30 dB
(Typical)	35 dB
Saturated Gain (Min)	24 dB
(Typical)	29 dB
Output VSWR (Max)	2.5 : 1
Input VSWR (Max)	2.5 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	27 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

Printed in U.S.A.

ELECTRICAL

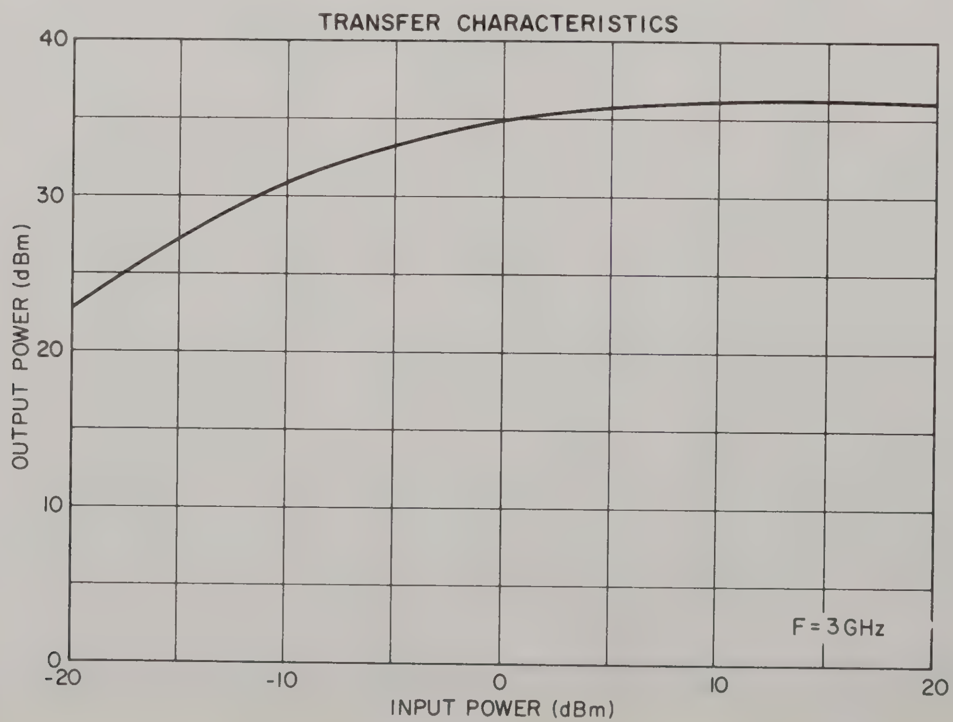
	Min.	Max.	Units
Cathode Voltage	-600	-800	V
Cathode Current	30	50	mA
Grid Voltage	0	25	V (Ref to Cath)
Grid Current	0	10	mA
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.5		A

ENVIRONMENT

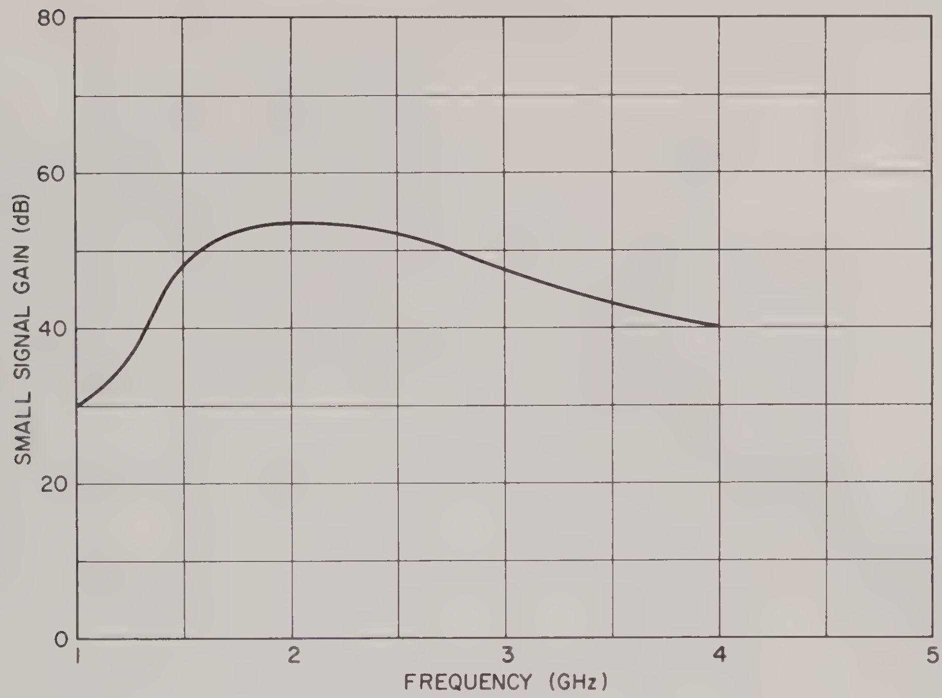
Vibration	15G, 5 to 500 c/s
Shock	25G, 11 ms
Acceleration	10G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

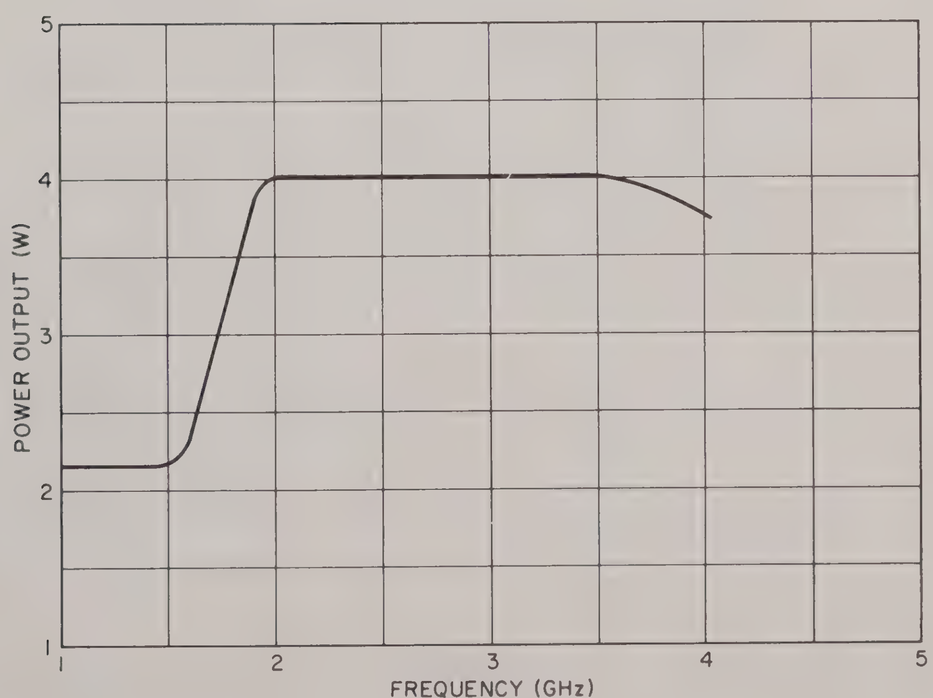
Length	8-3/4 in.
Width	1 in.
Height (excluding RF connectors)	1-1/8 in.
Weight	1-1/4 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	OSM Female
Mounting Position	Any

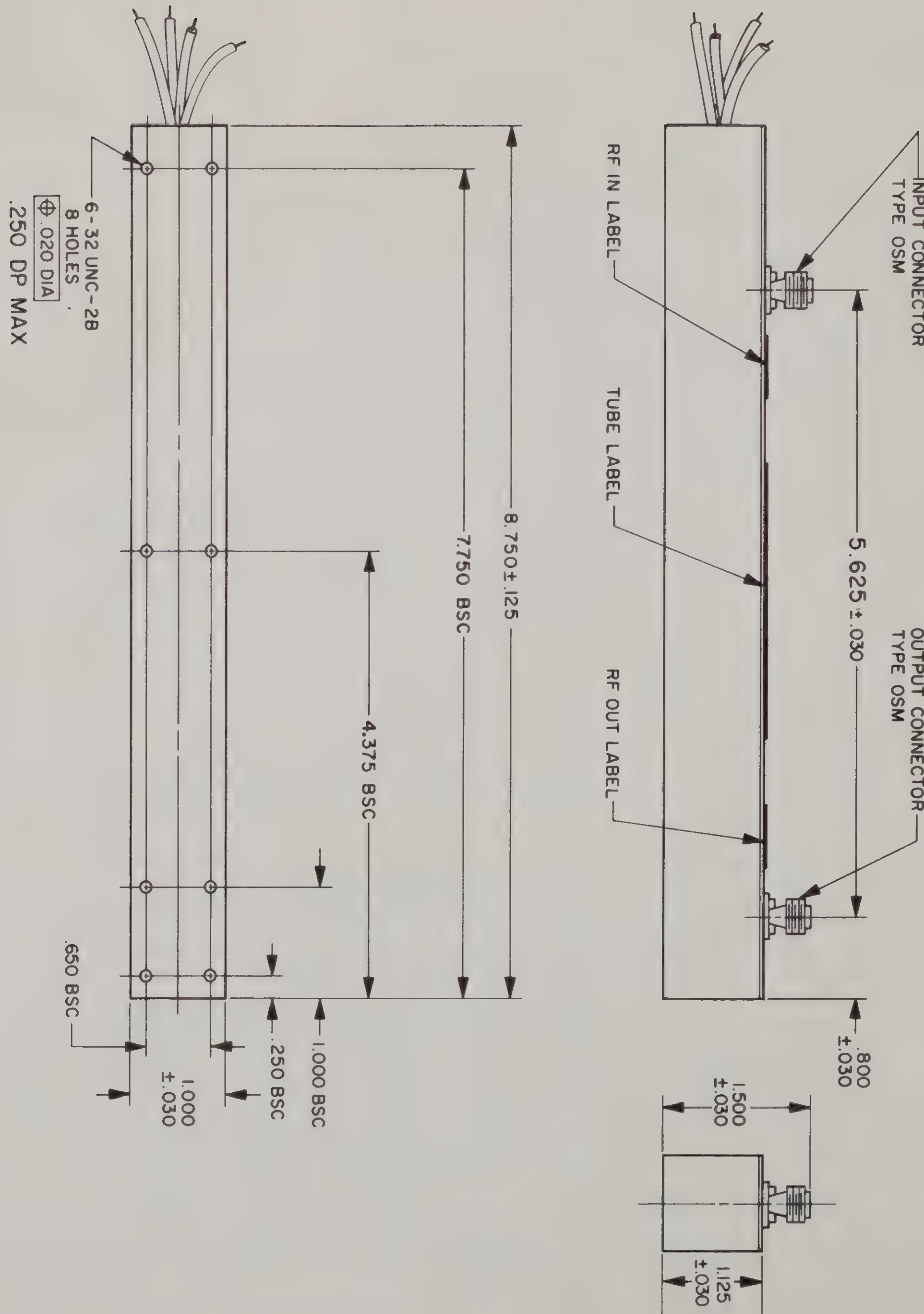


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
GREEN	FOCUS ELECTRODE
BLACK	BODY GROUND

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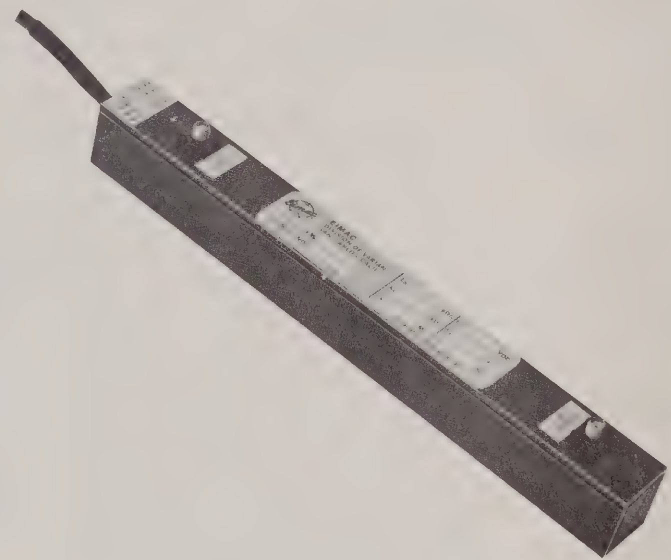
CALIFORNIA

EM-1602A

TRAVELING WAVE TUBE
4.0-12.4 GHz
1W C.W. Min.
30 dB Min. S.S.G.

The EM1602A TWT is one of a family of light weight, high performance TWTS available from EIMAC. Applications include both airborne and ground based systems subject to stringent environments where reliable, long life performance is of major concern. Typical applications include use as ECM drivers and radar augmenters, and in airborne radar, communications, and special test equipment.



FEATURES

- Small Size
- Light Weight
- Metal-Ceramic Construction
- PPM Focusing
- High Gain
- High Efficiency
- Broadband Operation
- Versatile Operation
- Conduction Cooling

GENERAL CHARACTERISTICS

PERFORMANCE

Frequency Range	4.0-12.4 GHz
Saturated Power Output (Min)	1 W
(Typical)	2 W
Small Signal Gain (Min)	30 dB
(Typical)	35 dB
Saturated Gain (Min)	24 dB
(Typical)	29 dB
Output VSWR (Max)	2.5 : 1
Input VSWR (Max)	2.5 : 1
Impedance (Nominal)	50Ω
Noise Figure (Max)	30 dB
(Typical)	25 dB

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070

Printed in U.S.A.

ELECTRICAL

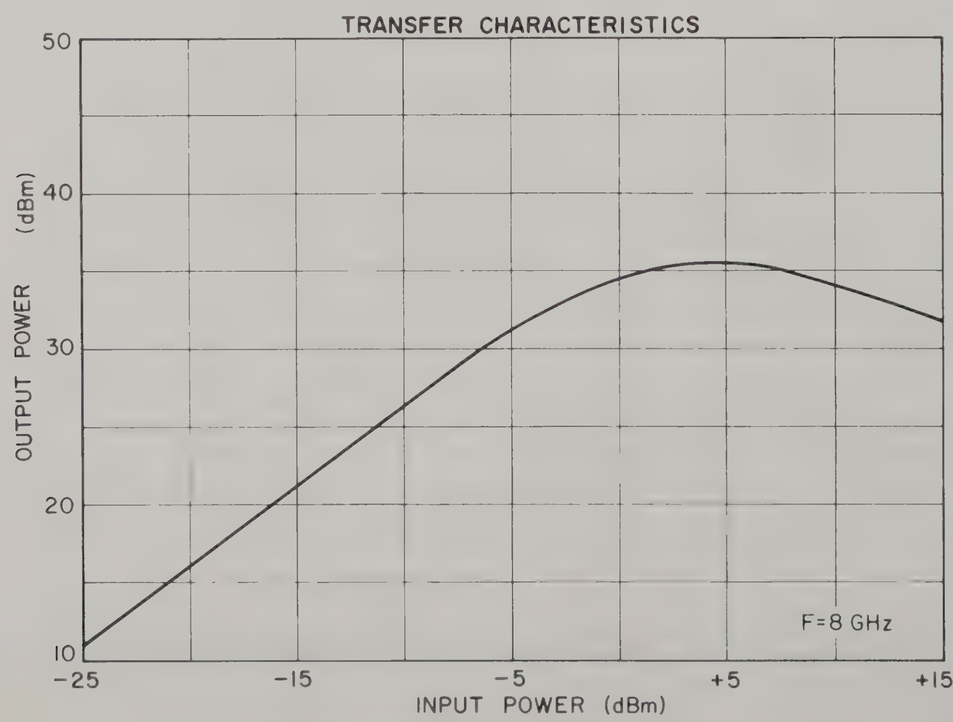
	Min.	Max.	Units
Cathode Voltage	-1950	-2250	V
Cathode Current	15	25	mA
Focus Electrode Voltage	-30	0	V (Ref to Cath)
Focus Electrode Current		0	
Helix Voltage	GND		ground
Collector Voltage	GND		ground
Heater Voltage (Nominal)	6.3		V
Heater Current (Nominal)	0.5		A

ENVIRONMENT

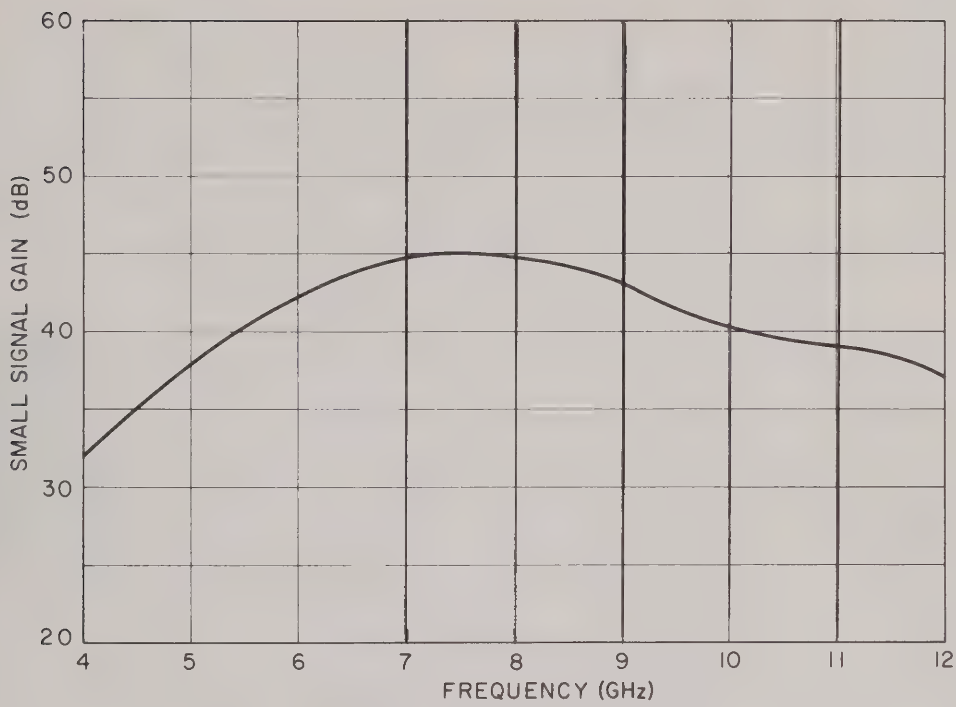
Vibration	15G, 5 to 500 cps
Shock	25G, 11 ms
Acceleration	10G, sustained
Temperature	-54°C to 85°C
Altitude (unpressurized)	to 70,000 ft

MECHANICAL

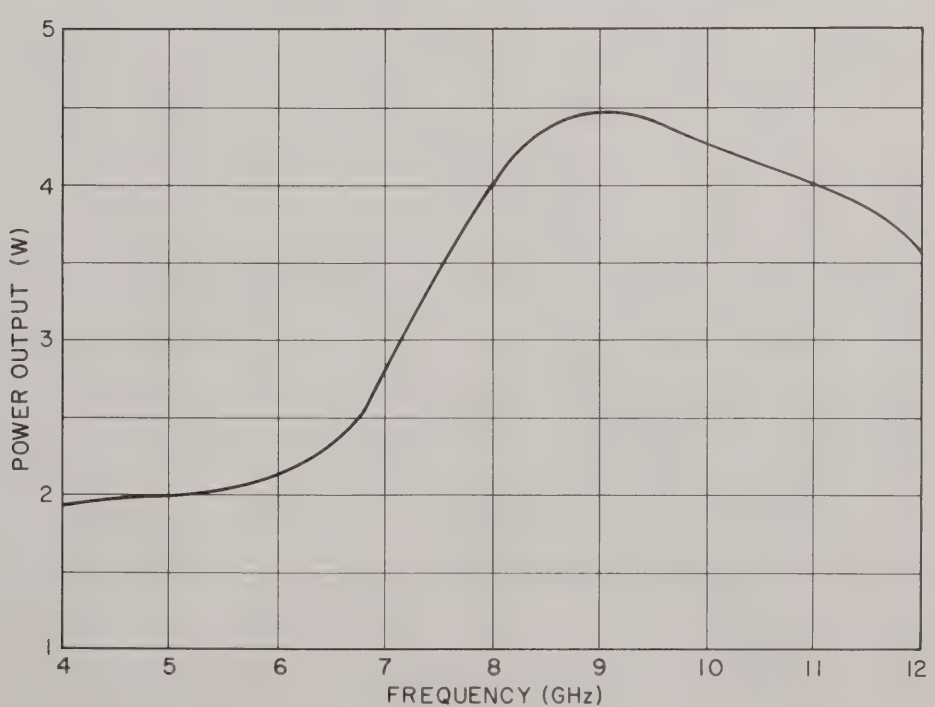
Length	7-3/4 in.
Width	1 in.
Height (excluding RF connectors)	1-1/8 in.
Weight	1-1/4 lb
Cooling	Conduction
D.C. Connections	Flying Leads
RF Connectors	OSM Female
Mounting Position	Any

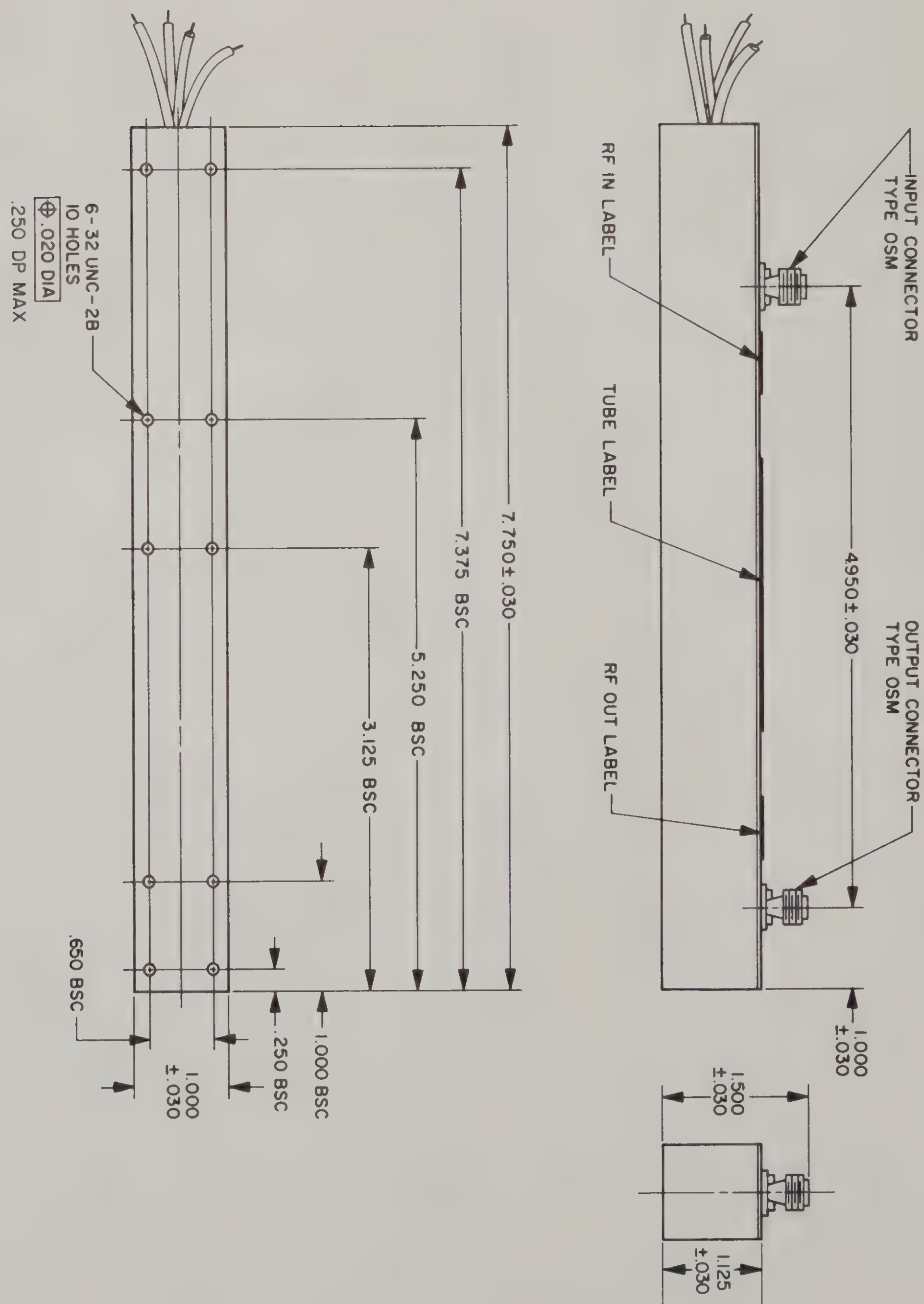


GAIN CHARACTERISTICS



POWER OUTPUT CHARACTERISTICS





LEAD	ELEMENT
BROWN	HEATER
YELLOW	HEATER CATHODE
BLACK	GROUND
GREEN	GRID

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EM-102
PULSED
TRAVELING WAVE TUBE
2.5-3.5 GHz
1.5kW Peak

The EM102 is a grid modulated pulse TWT designed for use in airborne and missile environments. It delivers 1.5 kW peak saturation output power over the band 2.5-3.5 GHz. The EM102 is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to + 125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	8.0 kV
Cathode Current	1.8A
Grid Bias Voltage	-300V
Duty Cycle	2%
Pulse Duration	10 μs
Heater Voltage	6.8V
Heater Surge Current	5.0A
Source VSWR	2.0 : 1
Load VSWR	2.5 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	2.5-3.5 GHz
Peak output, (Min)	1.5 kW
Gain for 1.5 kW Output, (Min)	35 dB
Heater Voltage	6.8V
Heater Current, Typ	1.6A
Heater Warm-Up Time (Min)	3.0 min
Grid Capacitance (To all other elements	40.0 pF
Grid Bias Voltage	-100V
Grid Drive Voltage[5]	+250V

PHYSICAL

Dimensions	See Outline
Weight, Approx.	7.5 lb
Mounting Position	Any
RF Connectors	TNC

TYPICAL OPERATING CONDITIONS[2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	7.6 kV
Cathode Current, Peak	1.4A
Grid Bias Voltage	-100V
Grid Current, Peak	150 mA
Duty	2%
Pulse Duration	8 μs

RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

	Min.	*Max.*
Load VSWR		2.0 : 1
Beam Voltage	7.0	8.0 kV
Cathode Current Peak	1.2	1.8A
Grid Current	100	250 mA
Heater Voltage	6.8	6.8V
Heater Current	1.0	2.5A
Grid Voltage	-80	-300V

(See Footnotes on Page 2)

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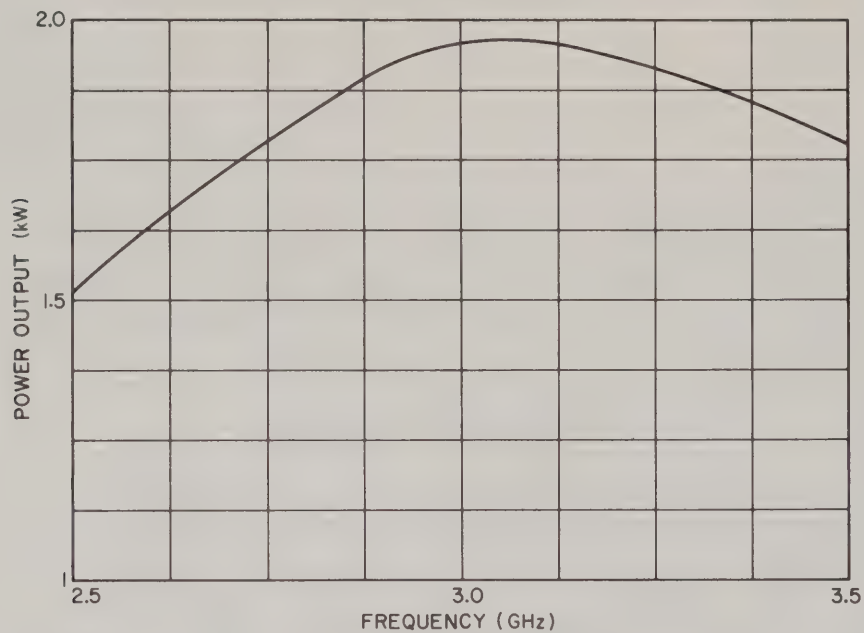
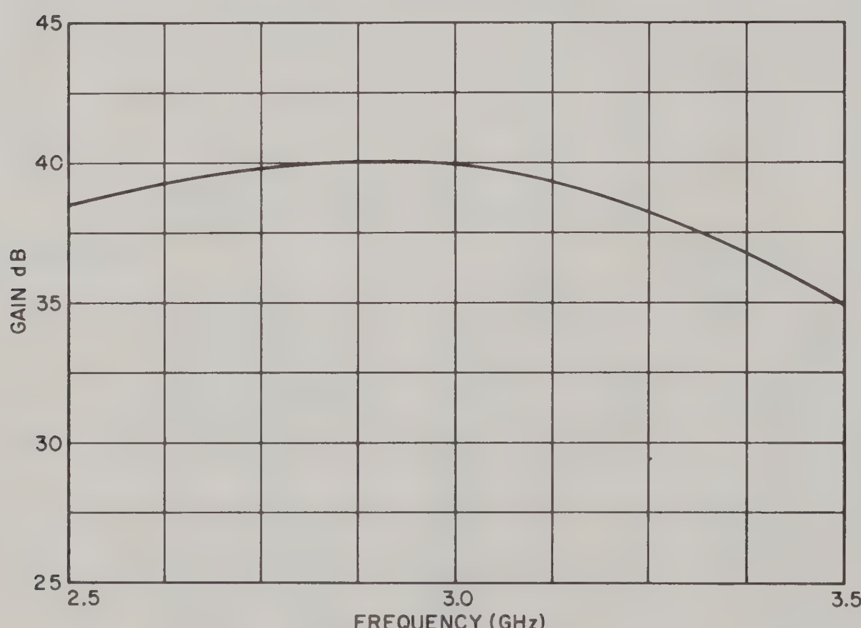
OUTPUT CHARACTERISTICS



GAIN CHARACTERISTICS



1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.

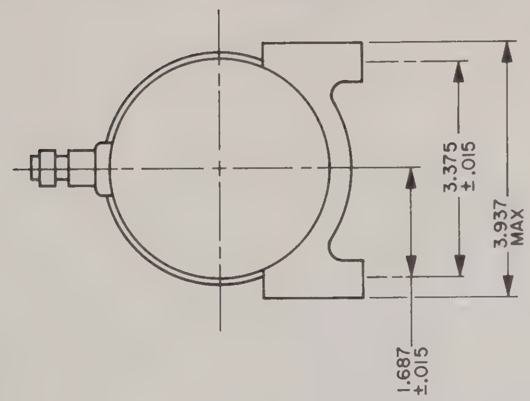
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.

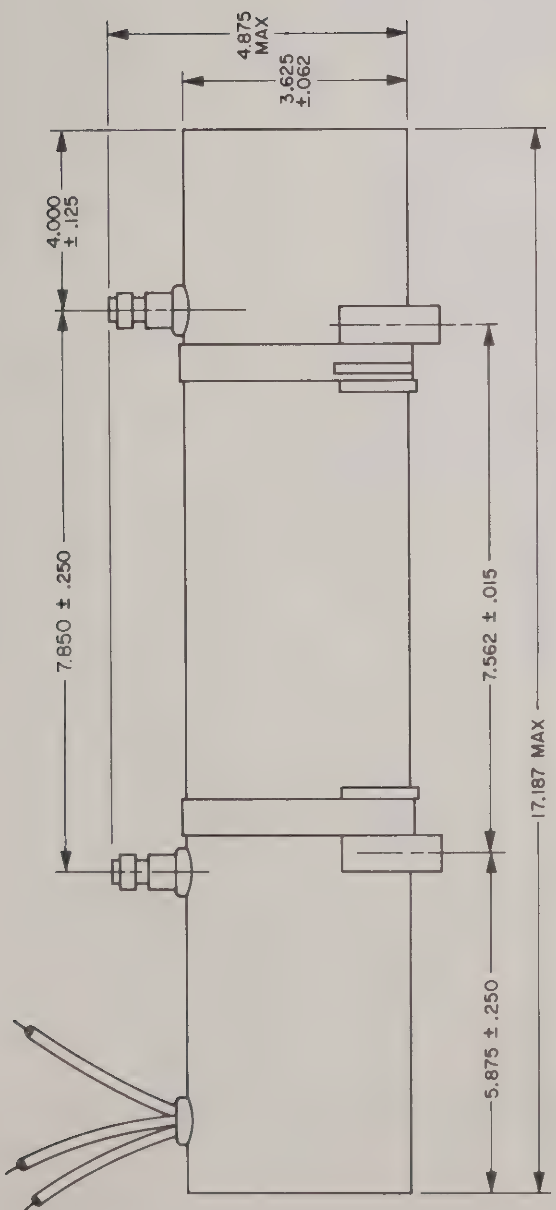
3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.

4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range.

5. Voltage reference: grid to cathode.

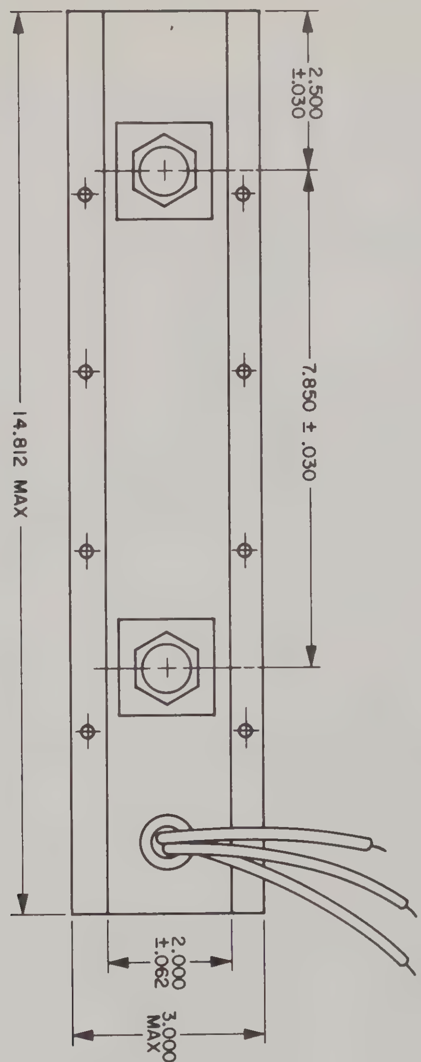
CONVECTION COOLED



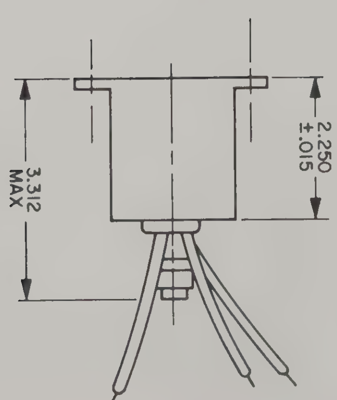


LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

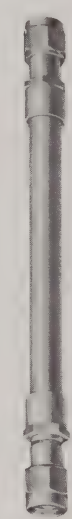
CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE



EM4529 EM4581 EM4582 EM4583
LOW PASS FILTERS



EM4582

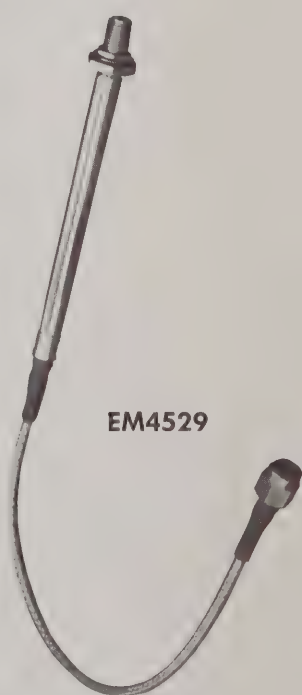
These low pass filters are recommended for use with UHF/Microwave telemetry transmitters, aerospace television transmitters and command/control transmitter exciters. Because of their small size and light weight, however, they are excellent for use in many other low-to-medium power transmitters. Their rugged construction results in reliable performance under the shock and vibration of missile launch. All models are coaxial, multiple-section reactive type filters. Silver plating is used to minimize insertion loss.

CHARACTERISTICS

MODEL	EM4581	EM4529	EM4582	EM4583
Pass Band, MHz - -	1435-1735	1435-1735	2200-2500	4400-5000
Power Rating, Watts, Avg.	100	50	100	50
Insertion Loss, DB, Max.	0.2	0.3	0.2	0.2
Attenuation, Second Harmonic, DB Min. -	45	45	45	45
Attenuation, Third and Fourth Harmonic, DB, Min. - - -	60	60	60	60
VSWR, Maximum - -	1.2	1.2	1.2	1.2
Impedance, Ohms, Nominal - - -	50	50	50	50
Connectors (male)[1] -	OSM	([2])	OSM	OSM

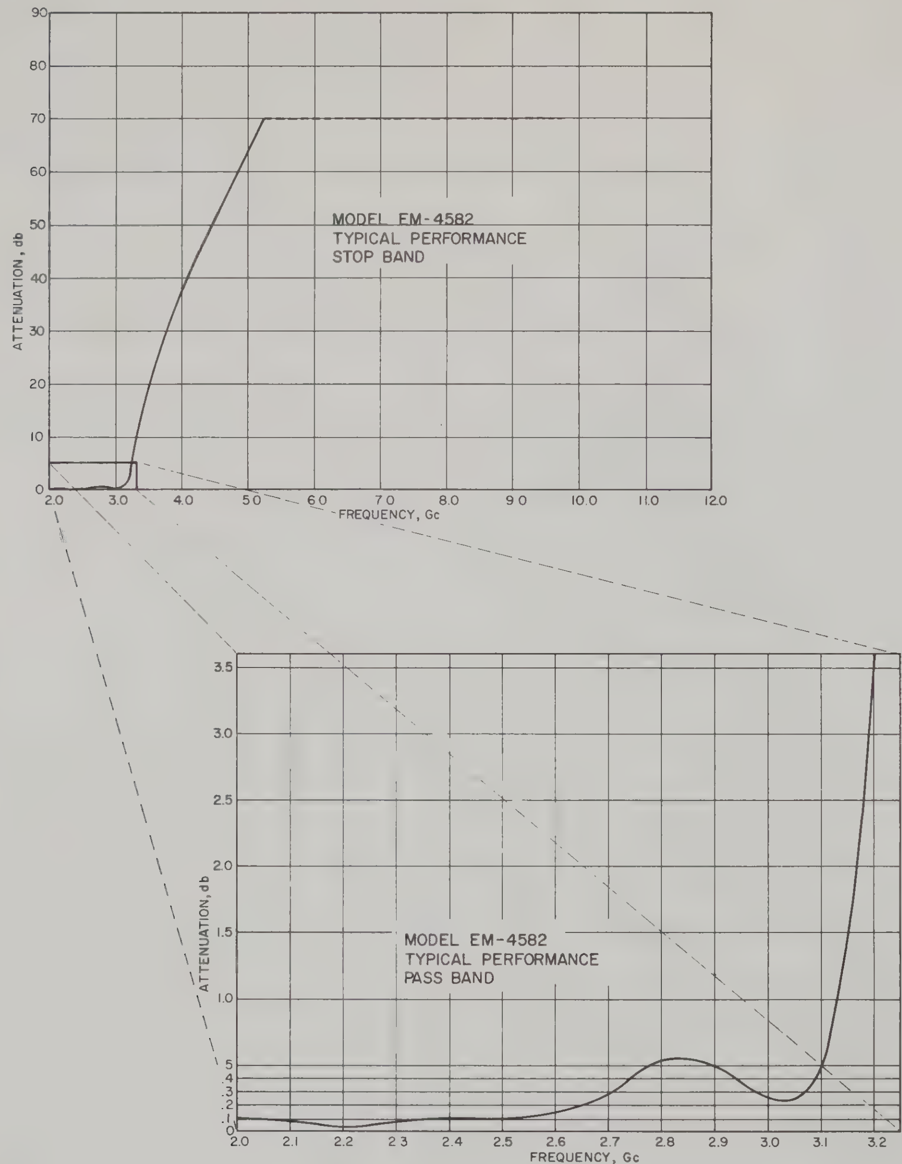
[1]Strip-line connectors also available.

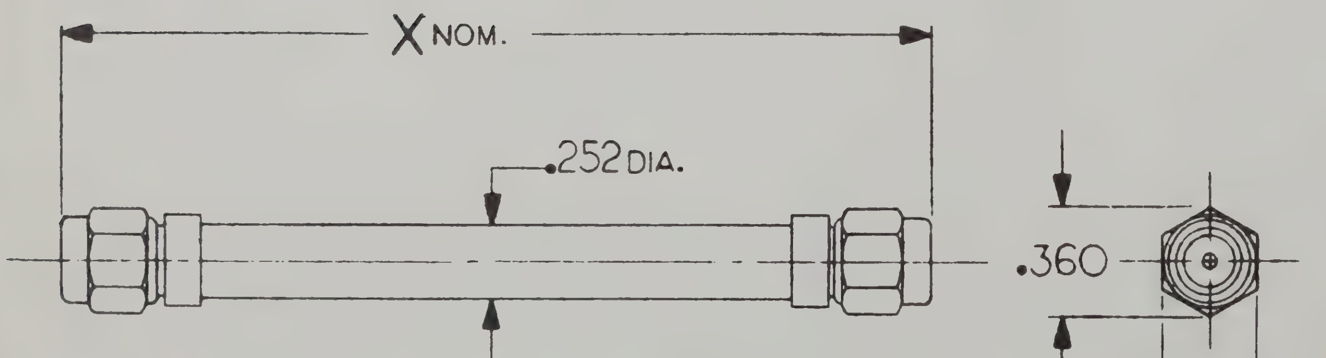
[2]OSM female panel-mount connector one end, OSM male connector with flexible cable other end.



EM4529

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.





MODEL	EM4581	EM4582	EM4583
X	3.340	2.953	3.279

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EM-102D

PULSED

TRAVELING WAVE TUBE

2.5-4.0 GHz

2.5kW Peak

The EM102D is a grid modulated pulse TWT designed for use in airborne and missile environments. It delivers 2.5 kW peak saturation output power over the band 2.5-4.0 GHz. The EM102D is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	10.0 kV
Cathode Current	2.2A
Grid Bias Voltage	-150V
Duty Cycle	2%
Pulse Duration	10 μs
Heater Voltage	6.8V
Heater Surge Current	3.6A
Source VSWR	2.0 : 1
Load VSWR	2.5 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	2.5-4.0 GHz
Peak Output, (Min)	2.5 kW
Gain for 2.5 kW Output, (Min)	30 dB
Heater Voltage	6.3V
Heater Current, Typ	1.6V
Heater Warm-Up Time (Min)	3.0 min
Grid Capacitance (To all other elements)	40.0 pF
Grid Bias Voltage	-100V
Grid-Drive[5]	+250V

PHYSICAL

Dimensions	See Outline
Weight, Approx	10 lb
Mounting Position	Any
RF Connectors	TNC

TYPICAL OPERATING CONDITIONS[2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	9.3 kV
Cathode Current, Peak	1.8A
Grid Bias Voltage	-100V
Grid Current, Peak	150 mA
Duty	2%
Pulse Duration	8 μs
Load VSWR	2.0 : 1

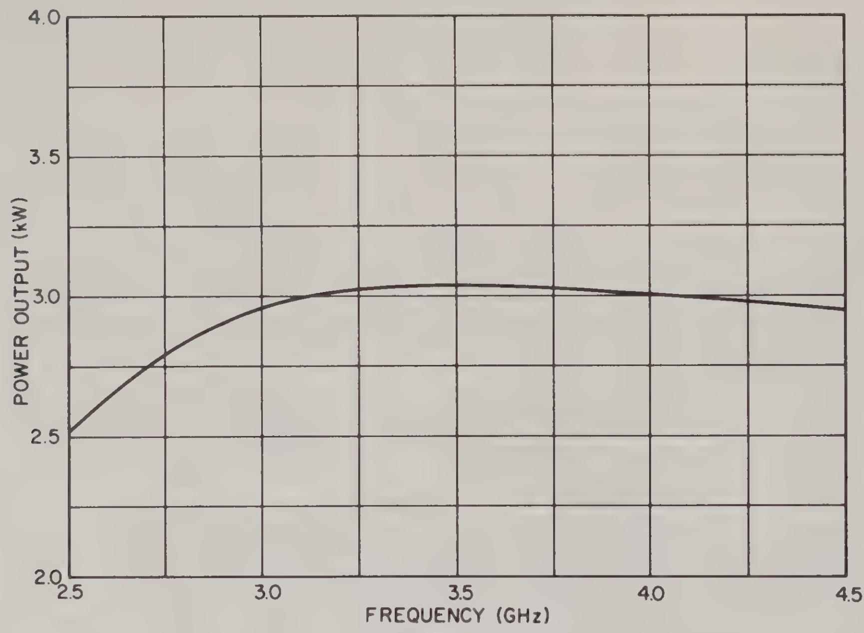
RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

	Min.	*Max.*
Beam Voltage	8.5	10.0 kV
Cathode Current Peak	1.2	2.2A
Grid Current	--	200 mA
Heater Voltage	5.8	6.8V
Heater Current	1.2	1.8V
Grid Voltage	-80	-150V

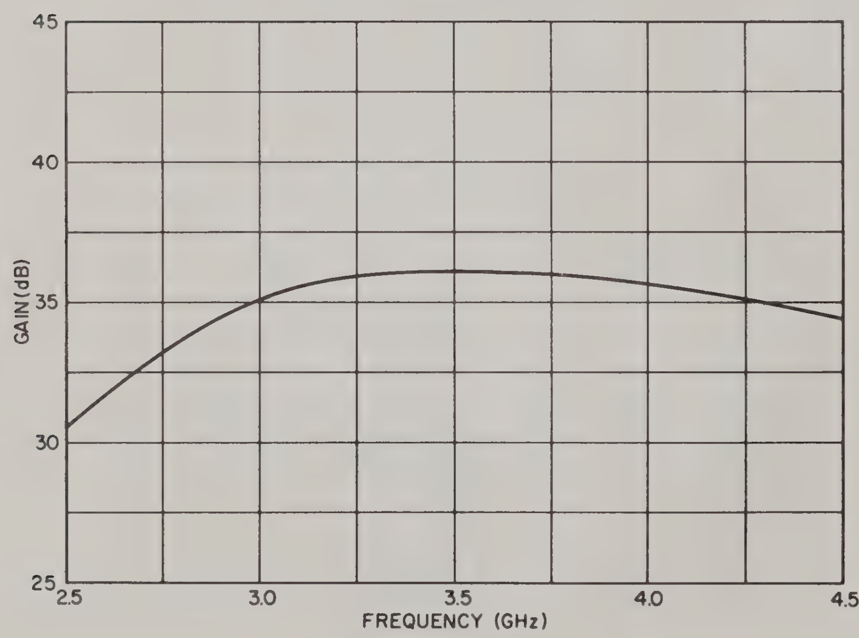
(See Footnotes on Page 2)

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

OUTPUT CHARACTERISTICS



GAIN CHARACTERISTICS



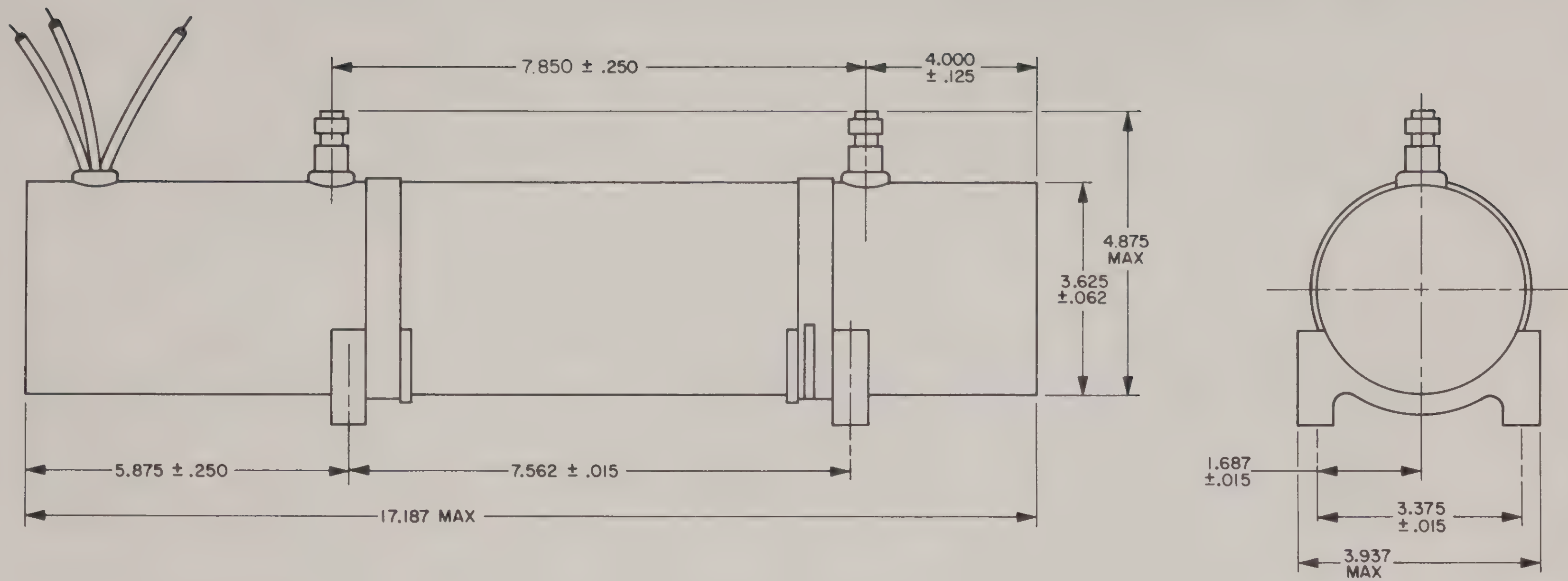
1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.

2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.

3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.

4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range of 1.2-1.5 GHz.

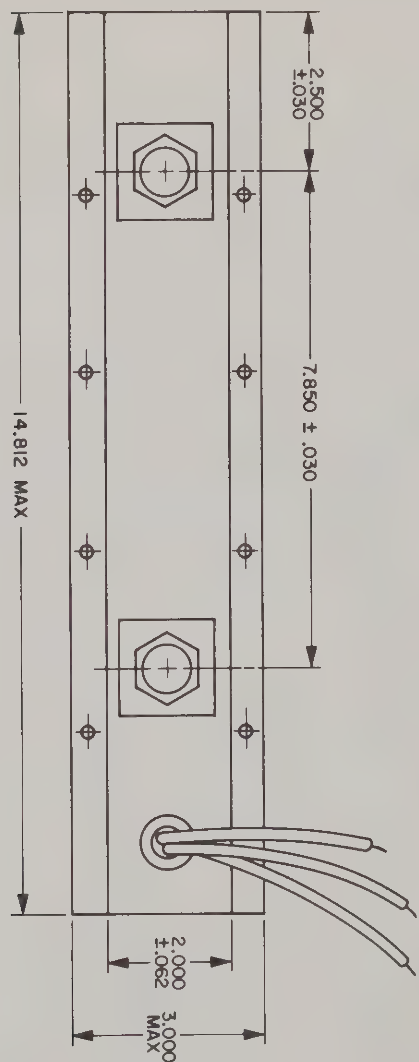
5. Voltage reference: grid to cathode.



CONVECTION COOLED

LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

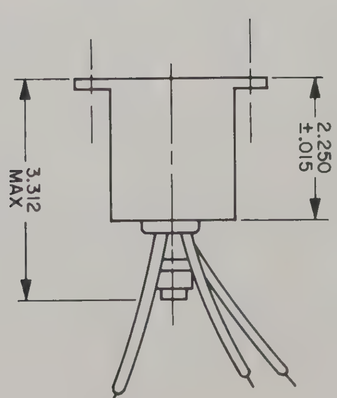


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TABLE OF CONTENTS
VOLUME II

Divider Sheets Not Available

Effective Date 9-1-66

3KM300LA
POWER AMPLIFIER KLYSTRON

100 KW CW

345-455 MHz

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

The EIMAC 3KM300LA power-amplifier klystron is intended for use in tropospheric scatter communications systems requiring single spans up to 600 miles in length. This klystron delivers 100 kW CW output power from 345 to 455 MHz with a power gain of 13 decibels.

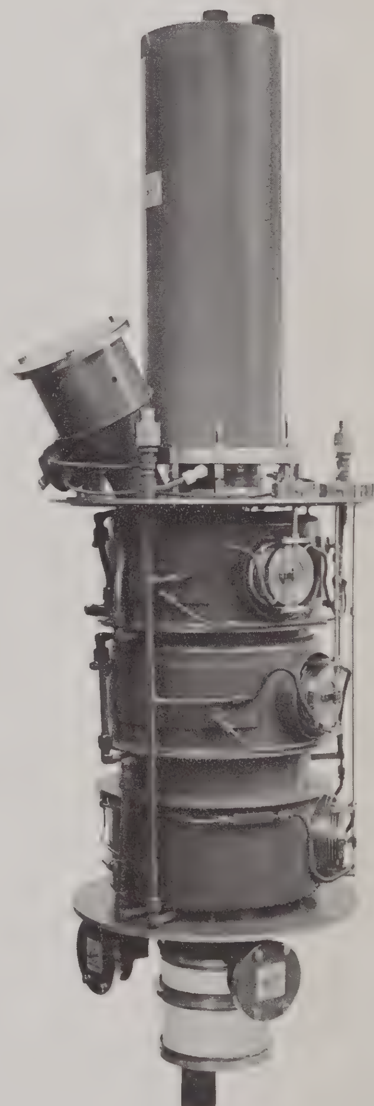
Three integral resonant cavities are used in the 3KM300LA. Both input and output couplings are fixed and an additional coupling is provided for input cavity loading.

The electron gun of this tube has a confined flow configuration which minimizes focusing adjustments and provides a quiet, stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting rf output, body current, or other performance characteristics.

The 3KM300LA incorporates a titanium getter which should be energized whenever heater power is applied. Also included is a getter ion pump which provides means for monitoring the condition of the vacuum during operation.

A focusing electromagnet and klystron supporting structure, Catalog Number H-172, is provided for use with the 3KM300LA.

EIMAC Water Load WL-160 is recommended for use with this klystron.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage	26 volts
Current	11.5 amperes
Cathode: EMA, Unipotential	
Heating Time	5 minutes
Getter: Voltage	4 volts
Current	25 amperes
Power Gain	13 decibels
Output Power	100 kilowatts
Frequency Range	345 to 455 megahertz
Phase shift as a function of beam voltage	0.01 degrees/volt

Printed in U.S.A.

MECHANICAL

Operating Position	Axis vertical, collector up
Coupling:	
Input	3⅛ inch, 50-ohm coaxial
Input Cavity Loading	3⅛ inch, 50-ohm coaxial
Output	6⅛ inch, 50-ohm coaxial
Weight (3KM300LA)	560 pounds
Weight (H-172)	642 pounds
Length (3KM300LA)	73 inches
Diameter (3KM300LA)	22 inches
Length (H-172)	31 inches
Diameter (H-172)	28 inches

Cooling: Water and Forced Air*	*Flow Rate*	*Pressure Drop*
Cathode	25 cfm	free
Body	5 gpm	40 psi
Collector	65 gpm	20 psi
Electromagnet	2 gpm	20 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Each of five coils	0 to 35 volts 0 to 20 amperes

MAXIMUM RATINGS

BEAM VOLTAGE	30 KILOVOLTS
BEAM CURRENT	9 AMPERES
BODY CURRENT	150 MILLIAMPERES
COLLECTOR DISSIPATION	270 KILOWATTS
OUTLET COOLANT TEMPERATURE	70° C
INPUT VSWR AT Fo	1.2:1
INPUT VSWR at ±0.5 MHz	1.3:1
OUTPUT LOAD VSWR	1.2:1

TYPICAL OPERATION, BROADBAND, CW AMPLIFIER**

Frequency	400 megahertz
Output Power	105 kilowatts
Driving Power	5 kilowatts
Power Gain	13.2 decibels
Beam Voltage	30 kilovolts
Beam Current	9 amperes
Modulating Anode Voltage (with respect to cathode)	27.8 kilovolts
Efficiency	39 percent
Body Current	50 milliamperes
Half-Power Bandwidth	2.0 megahertz
Input Cavity Loading	3.25 kilowatts
Electromagnet Currents:	
Coil #1	15 amperes
Coil #2	10 amperes
Coil #3	10 amperes
Coil #4	10 amperes
Coil #5	10 amperes

*These requirements are for operation at sea level and maximum ambient air temperature of 30° C. Maximum inlet water temperature is 30° C. At higher altitudes or higher temperatures, additional cooling may be required.
**This data was obtained from the prototype and does not necessarily represent typical characteristics of production klystrons.

For additional data or information regarding a specific application, write to EIMAC, Division of Varian, San Carlos, California.

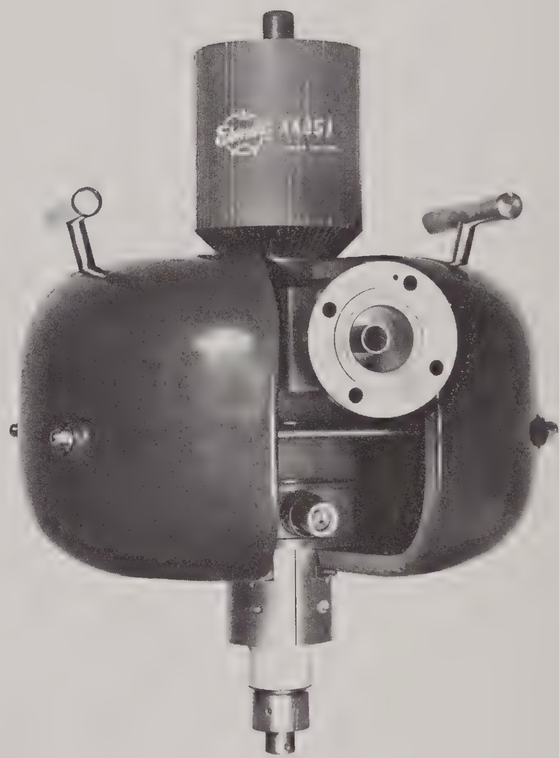
EIMAC

Division of Varian

4K3SJ

POWER AMPLIFIER S-BAND KLYSTRON

The EIMAC 4K3SJ is an air cooled, permanent magnet focused, power-amplifier klystron designed to operate at frequencies from 1700 to 2400 MHz. It will deliver a minimum output power of 1 kilowatt with minimum power gain of 40 decibels. The 4K3SJ is intended for use in applications where light weight and compactness are essential.



FEATURES

- PERMANENT MAGNET FOCUSING
- FOUR INTEGRAL CAVITIES
- LOW NOISE LEVEL
- FIXED INPUT AND OUTPUT COUPLING
- TWO LIFTING HANDLES FOR EASE OF HANDLING
- INSTANT FAULT RECYCLING

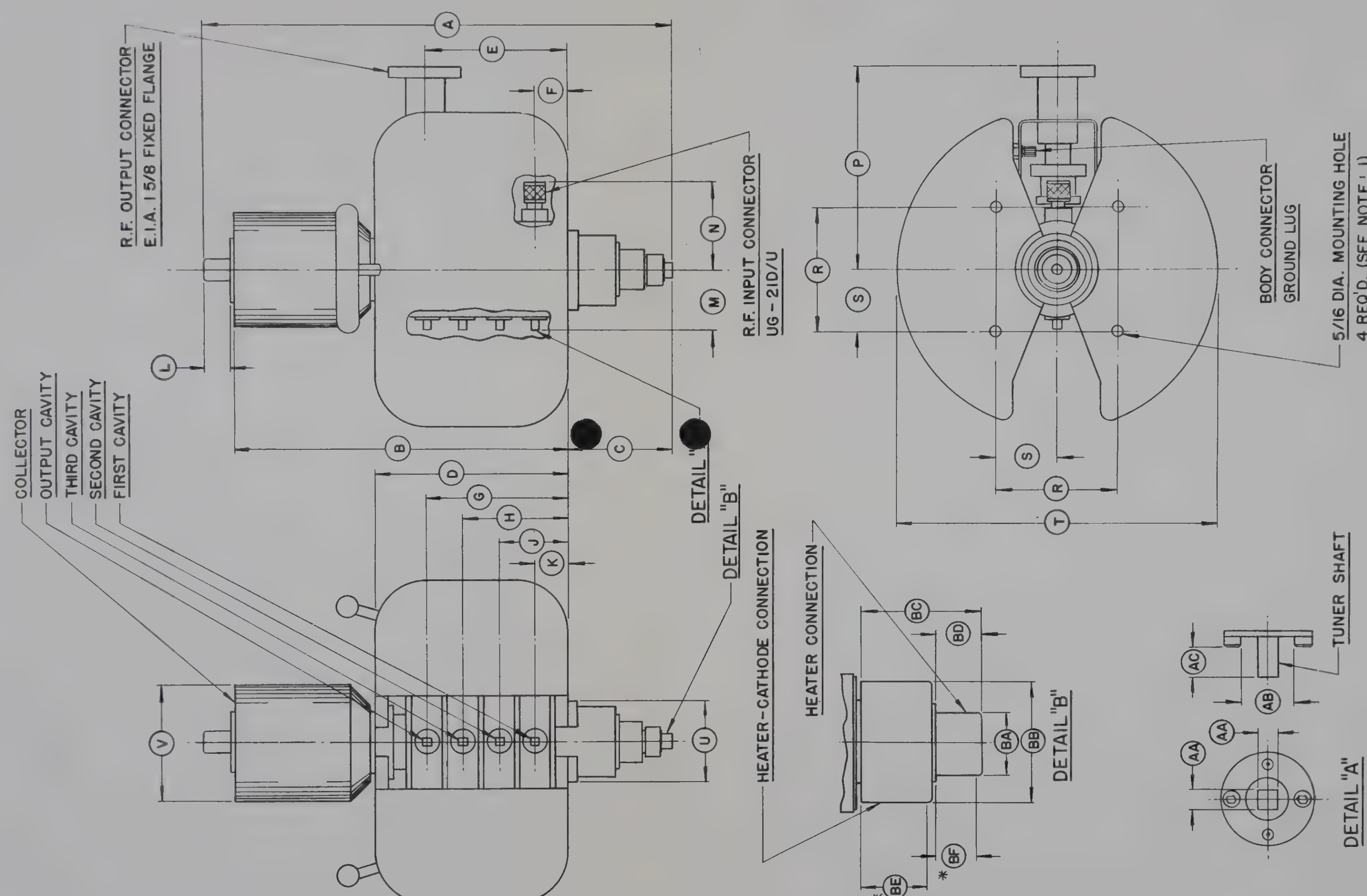
CHARACTERISTICS

ELECTRICAL

Frequency	1700-2400 MHz
Minimum Output Power	1 kW
Minimum Power Gain	40 db
Cathode: Impregnated Unipotential	
Starting Time	3 minutes
Heater: Voltage	6 volts
Current	4.5 amperes
Maximum Starting Current	9 amperes

Printed in U.S.A.

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A			19.000
B	13.475		
C	4.544		
D			7.874
E	5.320		
F	1.470		
G	5.320		
H	4.370		
J	2.920		
K	1.470		
L			.750
M	2.472		
N	3.475		
P	7.910		
R		4.888	5.012
S		2.444	2.506
T			3.196
U			3.042
V	4.333		
AA		.248	.252
AB		.647	
AC		.340	
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		530	
BE		.830	
BF		.450	



NOTES:
1. KEEP MAGNETIC MATERIALS AT LEAST SIX INCHES AWAY FROM MAGNET; OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT.

4K3SJ KLYSTRON

4K3SJ Eimac

MECHANICAL

Operating Position (preferred)	Vertical, cathode down
Cavity Tuning Torque (maximum)	12 inch pounds
Cooling	Forced Air (20°C at sea level)
Collector Flow	200 cfm
Collector Pressure Drop	1.5 inches H_2O

Body and cathode seals require cooling only at higher temperatures or lower pressures.

Maximum Dimensions:	
Length	18.4 inches
Width	13.25 inches
Depth	14 inches
RF Input Coupling	UG-21 D/U Connector
RF Output Coupling	1⅝ inch, 50-ohm line
Weight (Klystron and Magnet)	85 pounds

MAXIMUM RATINGS

DC BEAM VOLTAGE	7.0 KILOVOLTS
DC BEAM CURRENT	0.6 AMPERE
DC BEAM INPUT POWER	4 KILOWATTS
COLLECTOR DISSIPATION	4 KILOWATTS
CATHODE SEAL TEMPERATURE	150 DEGREES C
LOAD VSWR	2:1

TYPICAL OPERATION — TUNED FOR MAXIMUM EFFICIENCY

Frequency	1700	2000	2400	megahertz
Output Power	1.17	1.08	1.03	kilowatts
Driving Power	20	25	30	milliwatts
Gain	47.6	46.3	45.3	decibels
DC Beam Voltage	6	6	6.2	kilovolts
DC Beam Current	0.54	0.54	0.56	ampere
Beam Power Efficiency	36.2	33.4	31.8	percent
3 db Bandwidth	4	4.5	6	megahertz

For additional data or information regarding a specific application, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California.

EIMAC

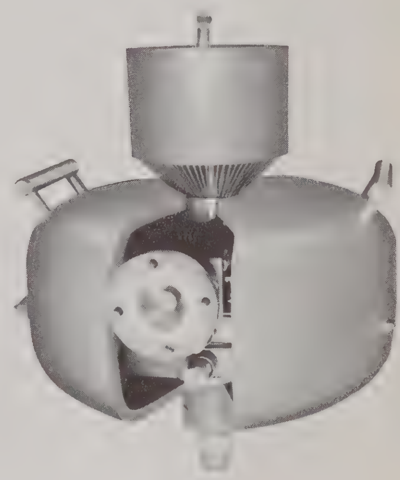
A Division of Varian Associates

S A N   C A R L O S ,   C A L I F O R N I A

4K5SL-1

2 kW POWER AMPLIFIER S-BAND KLYSTRON

The EIMAC 4K5SL-1 is an air-cooled, permanent magnet focused, power-amplifier klystron designed to operate at frequencies from 1700 to 2400 megahertz. It will deliver a minimum output power of 2 kilowatts with a minimum power gain of 40 decibels. The 4K5SL-1 is intended for use in applications where broad communications bandwidth, light weight and compactness are essential. The second cavity is designed to be coupled to an external load for increased bandwidth.



FEATURES

- PERMANENT MAGNET FOCUSING
- FOUR INTEGRAL CAVITIES
- SECOND CAVITY LOADING
- LOW NOISE LEVEL
- FIXED INPUT AND OUTPUT COUPLING
- TWO LIFTING HANDLES FOR EASE OF HANDLING

CHARACTERISTICS

ELECTRICAL

Frequency	1700-2400 MHz
Minimum Output Power	2 kW
Minimum Power Gain	40 db
Minimum Bandwidth	4 MHz
Cathode: Impregnated, Unipotential	
Starting Time (Minimum, without damage)*	3 Min.
Heater: Voltage	6 Vac
Current	4.5 Aac
Maximum Starting Current	9 Aac

*Cathode emission will be stabilized in 5 minutes

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

MECHANICAL

Operating Position	Any
Cavity Tuning Torque (maximum)	12 inch-pounds
Cooling**	Forced Air (20°C at sea level)
Collector Flow	225 CFM
Collector Pressure Drop	0.8 inch H_2O
Body Flow	40 cfm
Pressure Drop	1.0 inch H_2O
Maximum Dimensions:	
Length	20 inches
Width	14.5 inches
Input rf Coupling	UG-21 D/U Connector
Second Cavity Coupling	UG-21 D/U Connector
Output rf Coupling	1⅝ inch, 50-ohm line
Weight (Klystron and Magnet)	95 Pounds

**Cooling air drawn through body and collector and exhausted away from klystron.

MAXIMUM RATINGS

BEAM VOLTAGE	8.6	kVdc
BEAM CURRENT	0.8	Adc
COLLECTOR DISSIPATION	6.87	kW
CATHODE SEAL TEMPERATURE	150°C	
LOAD VSWR	1.5:1	

TYPICAL OPERATION

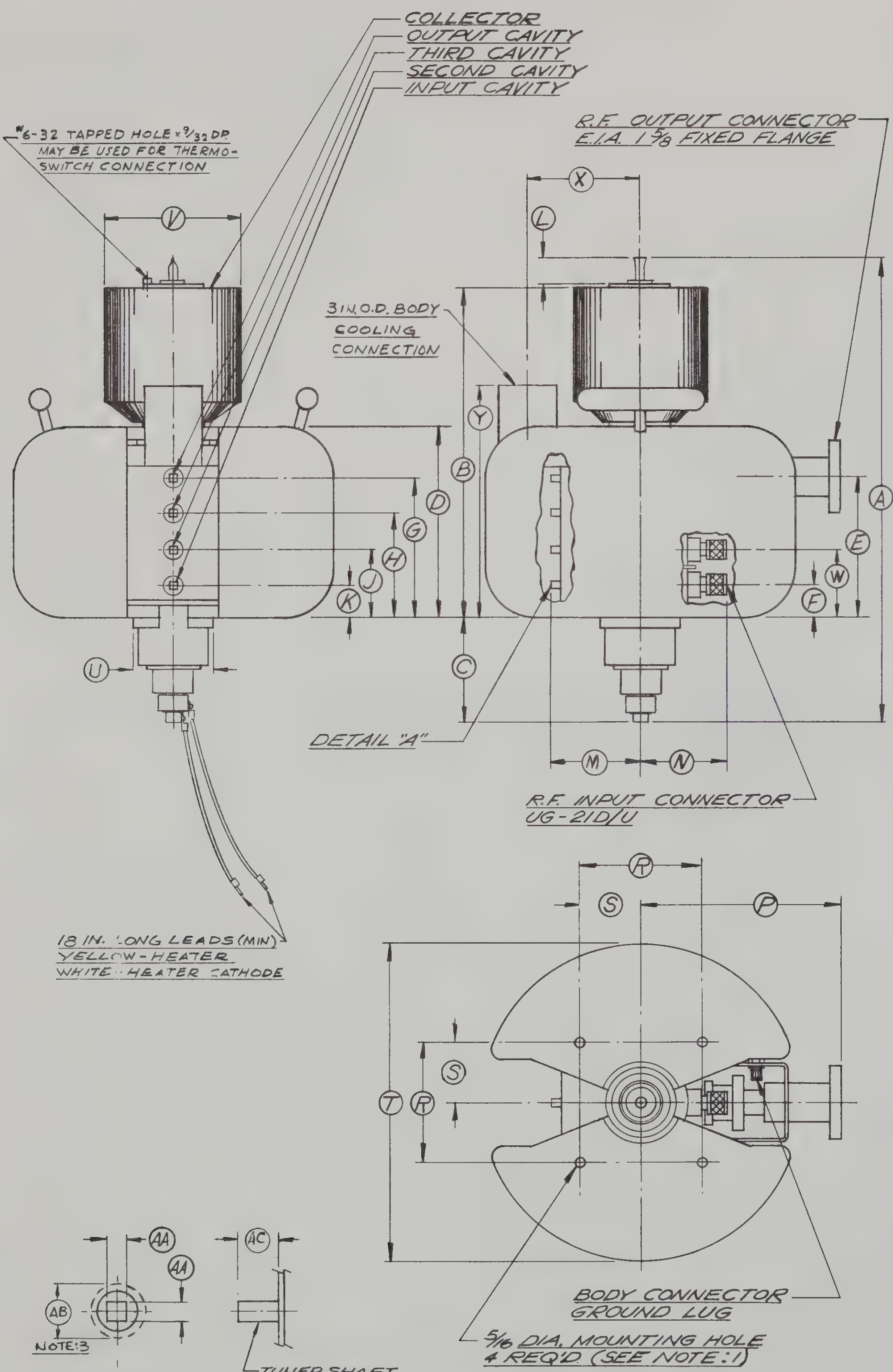
Tuned For Maximum Efficiency — Load VSWR 1.1:1

	2.0 kW Minimum Output Level			
Frequency	1700	2000	2400	MHz
Output Power	2.250	2.050	2.050	kW
Driving Power	100	100	100	mW
Gain	43.52	43.22	43.12	db
Beam Voltage	7.8	7.8	8.4	kVdc
Beam Current	.590	.590	.650	Adc
Beam Power Efficiency	49	44.5	37.5	%
3 db Bandwidth	4	4.5	6.0	MHz

	1 kW Minimum Output Level			
Frequency	1.7	2.0	2.4	MHz
Beam Voltage	6.5	6.5	6.5	kVdc
Beam Current	.450	.450	.450	Adc
Output Power	1.270	1.148	1.025	kW
Driving Power	100	100	100	mW

	500 Watts Minimum Output Level			
Frequency	1.7	2.0	2.4	MHz
Beam Voltage	5.4	5.4	5.4	kVdc
Beam Current	.337	.337	.337	Adc
Output Power	.625	.562	.520	kW
Driving Power	100	100	100	mW

For additional data or information regarding a specific application, write to EIMAC, Division of Varian Associates, 301 Industrial Way, San Carlos, California.



DIMENSIONAL DATA			
REF	NOM.	MIN.	MAX.
A			20.000
B	13.475		
C			4.625
D			7.874
E	5.820		
F	1.470		
G	5.820		
H	4.370		
J	2.920		
K	1.470		
L			1.500
M	4.472		
N	3.475		
P	7.910		
R		4.888	5.012
S		2.444	2.506
T			14.500
U			3.042
V		6.000	6.125
W	2.920		
X	5.125		
Y	10.000		
AA		.245	.255
AB		.647	
AC		.340	

NOTES:

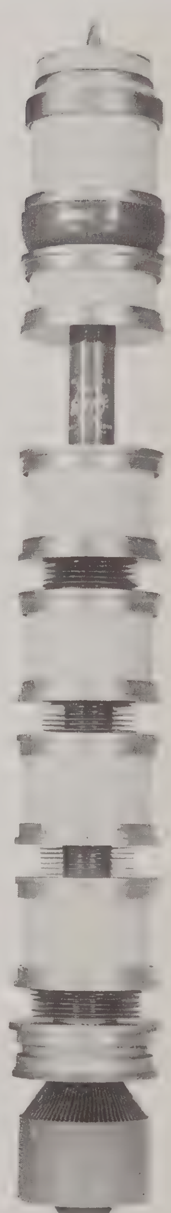
1. KEEP MAGNETIC MATERIAL AT LEAST SIX INCHES AWAY FROM MAGNET; OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. CYLINDER OF CLEARANCE TO BE CENTERED ON EACH TUNER SHAFT.

4K5SL-1 KLYSTRON

EIMAC
Division of Varian

4KM3000LR

POWER-AMPLIFIER L-BAND KLYSTRON



The EIMAC 4KM3000LR is a four-cavity, magnetically-focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 610 and 985 megahertz and under narrow-band conditions will deliver a minimum CW output power of 2 kilowatts with a power gain of at least 45 decibels.

This klystron employs the EIMAC Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits or when grounded through a resistor.

The resonant cavities for the 4KM3000LR are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplshed outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

EIMAC Klystron Amplifier Circuit Assembly H-125, for use with the 4KM3000LR, covers the frequency range of 610 to 985 megahertz. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable load couplers for the input, second, penultimate and output cavities, and an SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Minimum Heating Time	5	minutes
Heater: Voltage (±5%)	5.0	volts
Current	31.0	amperes
Maximum Starting Current	65.0	amperes
Typical Power Gain (Narrow Band)	45	db
Minimum Output Power (Narrow Band)	2000	watts
Frequency Range (H-125 Assembly)	610 to 985	MHz

MECHANICAL

Operating Position (H-125 Assembly)	Vertical, cathode end up
R-F Coupling:	
Input	Type "N" 50-ohm receptacle
Input Cavity Loading	Type "N" 50-ohm receptacle
Second Cavity Loading	Type "N" 50-ohm receptacle
Penultimate Cavity Loading	Type "N" 50-ohm receptacle
Output	1⅝ inch 50-ohm line

Cooling: (20°C inlet air at sea level)	*Flow Rate*	*Pressure Drop*
Cathode (with SK-110 Air-System Socket)	5 cfm	0.4 inch H_2O
Penultimate Cavity	50 cfm	0.9 inch H_2O
Output Cavity	50 cfm	0.9 inch H_2O
Collector	150 cfm	1.8 inches H_2O

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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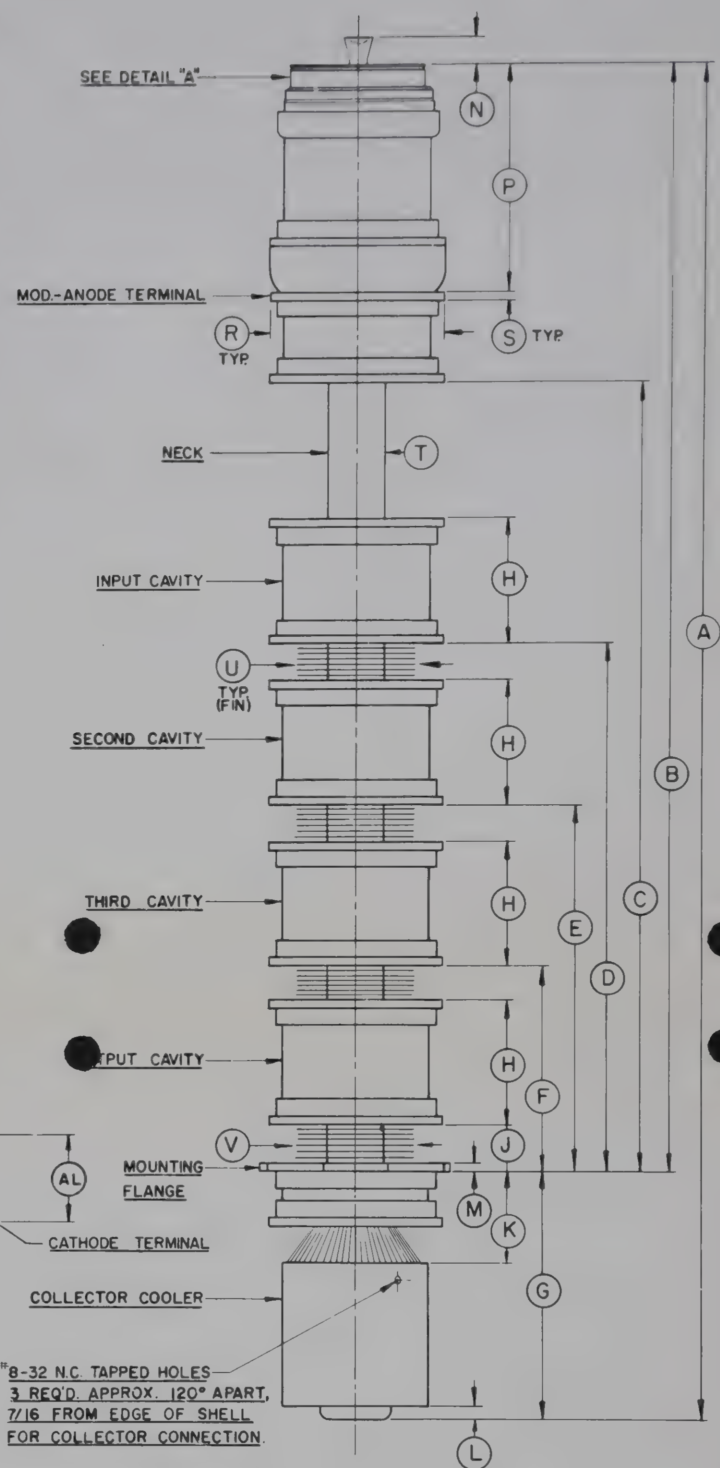
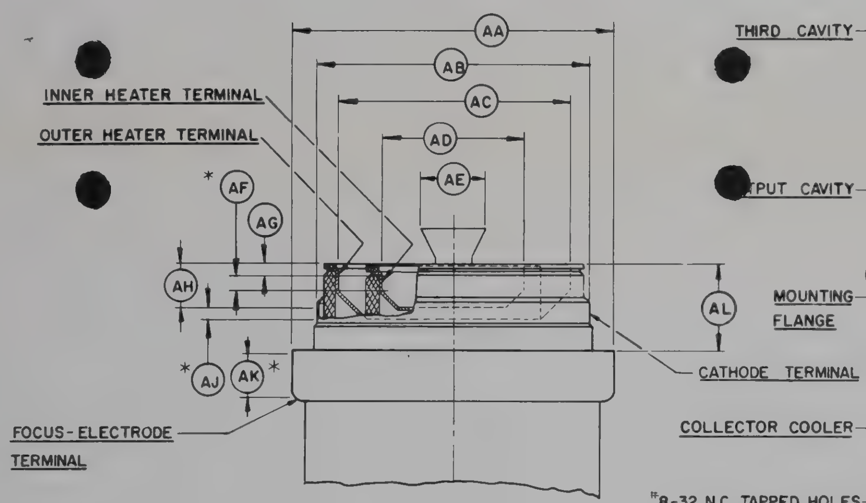
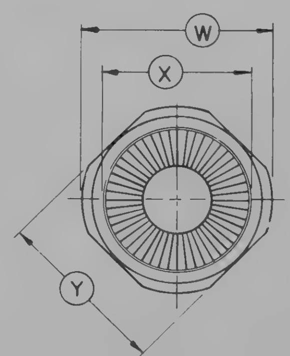
DIMENSIONAL DATA					
REF.	MIN.	MAX.	REF.	MIN.	MAX.
A	36.500	37.000	AA	4.300	4.450
B	30.800	31.000	AB	3.750	3.835
C	22.000	22.150	AC	3.100	3.200
D	14.750	14.900	AD	1.865	1.950
E	10.250	10.375	AE		1.000
F	5.750	5.875	AF	.100	
G	5.825	5.975	AG	.125	.175
H	3.490	3.540	AH	.670	.775
J	1.240	1.370	AJ	.100	
K	2.675	2.825	AK	.500	
L		.750	AL	1.000	1.500
M	.230				
N		1.500			
P	6.200	6.350			
R	4.610	4.635			
S	.240				
T	1.475	1.520			
U	3.080 (NOM)				
V	3.580 (NOM)				
W	5.115	5.135			
X	4.115	4.145			
Y	4.630 (NOM.)				

NOTES:
1. DIMENSIONS IN INCHES.
2. *MINIMUM CONTACT SURFACES.





DETAIL "A"



4KM3000LR OUTLINE DRAWING

MECHANICAL (continued)

Maximum Over-All Dimensions:	
Length	38½ inches
Diameter	5⅛ inches
Net Weight	38 pounds
Shipping Weight (Approximate)	90 pounds

MAXIMUM RATINGS

DC BEAM VOLTAGE*	10	KILOVOLTS
DC BEAM CURRENT*	0.750	AMPERE
DC BODY CURRENT (CONTINUOUS)	75	MILLIAMPERES
DC BODY CURRENT (TUNING ONLY)	100	MILLIAMPERES
FOCUS ELECTRODE VOLTAGE	—500	VOLTS
COLLECTOR DISSIPATION	3000	WATTS
TUBE TEMPERATURES	175	DEGREES C

*These ratings are not to be applied simultaneously.

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil Voltage	0 to 50	volts
Prefocus-Coil Current	0 to 1.25	amperes
Three Body Coils and Collector Coil in Series:		
Voltage	0 to 350	volts
Current	0 to 2.25	amperes

TYPICAL OPERATION

Narrow-Band, CW Amplifier (In H-125 Circuit Assembly)

Frequency	900	megahertz
Output Power	2100	watts
Driving Power	0.050	watt
Power Gain	46	db
D C Beam Voltage	8500	volts
D C Beam Current	0.550	ampere
Beam Input Efficiency	45	percent
D C Body Current	50	milliamperes
D C Collector Current	0.500	ampere
Focus-Electrode Voltage	—200	volts
Magnetic-Coil Currents**		
Prefocus	0.65	ampere
Body Coils and Collector Coil in Series	1.75	amperes

**Approximate values

In the event of loss of driving power, the collector dissipation rating of the 4KM3000LR may be exceeded. Therefore, the collector should be fitted with a thermal overload device, interlocked with the beam control circuitry, and set to operate at a collector temperature equal to or greater than 175° Centigrade.

For additional information or information regarding any specific application, write to High Power Microwave Marketing, EIMAC Division of Varian, San Carlos, California. All such requests will be handled confidentially.

EIMAC

Division of Varian

5K70SH

S-BAND

30 KW CW

POWER AMPLIFIER KLYSTRON

The EIMAC 5K70SH power amplifier klystron was designed specifically for industrial heating applications. The outstanding characteristic of this klystron is its high efficiency at full power. The 5K70SH delivers 30 kilowatts output power at better than 50% efficiency at 2450 MHz with a minimum gain of 50 db.

An extra large cathode is used in the 5K70SH to assure long life. Five integral cavities are employed for high gain, and all are pre-tuned at the factory. Also, input and output couplings are factory adjusted. In short, no tuning of any kind is required.

The output "window," where microwave power is transferred from the vacuum within the klystron to the external waveguide, is made of beryllium oxide. This insulating material has extremely good heat-transfer and mechanical characteristics. It is virtually indestructible in this application.

A focusing electromagnet, Catalog Number H-226, has been designed for use with the 5K70SH. EIMAC Water Load WL-204 is recommended for use with this klystron.

CHARACTERISTICS

ELECTRICAL

Heater: Voltage (±5%)	7.5	Vac
Current (nominal)	11.5	Aac
Cathode: Oxide Coated		
Heating Time	5	Min
Getter: Voltage	4	Vac
Current	24	Aac
Power Gain	50	db
Output Power	30	kW
Frequency	2450	MHz
Phase Shift as a Function of Beam Voltage	0.0935	°/V

Printed in U.S.A.

MECHANICAL

Operating Position		Any
Input rf Coupling		Type N Coaxial Fitting
Output rf Coupling		UG435A/U Flange
Weights: 5K70SH		100 lbs
H-226 Electromagnet		186 lbs
Cooling: Forced Air and Water	*Flow Rate*	*Pressure Drop*
Cathode	20 cfm	Free
Klystron Body	0.8 gpm	50 psi
Klystron Collector	18 gpm	30 psi
Electromagnet	2 gpm	30 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage, Adjustable to	150 Vdc
Current, Adjustable to	25 Adc

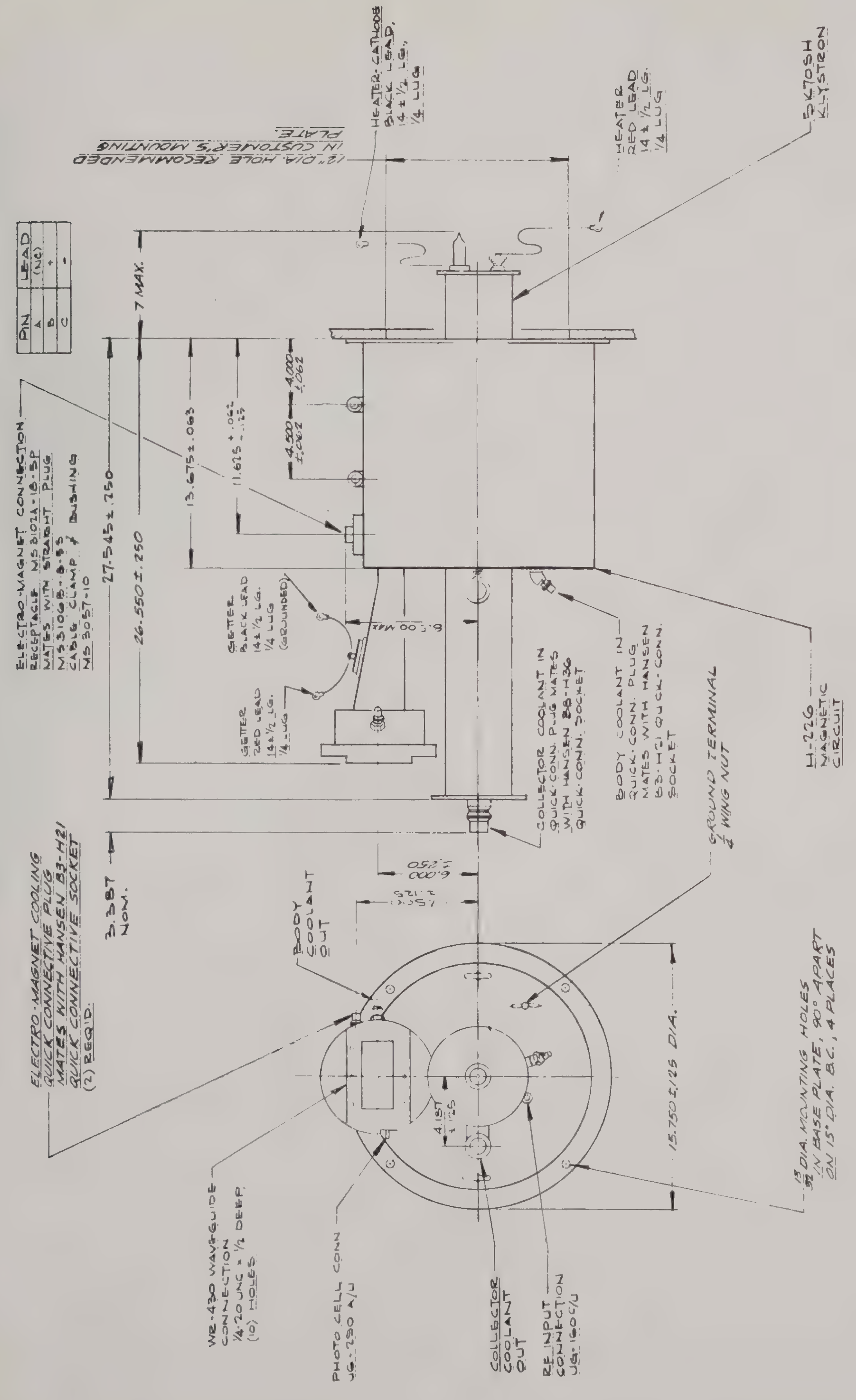
MAXIMUM RATINGS

BEAM VOLTAGE	23 kVdc
BEAM CURRENT	3 Adc
BEAM INPUT POWER	70 kW
BODY CURRENT	100 mAdc
COLLECTOR DISSIPATION	70 kW
INLET COOLANT PRESSURE	125 psig
COOLANT OUTLET TEMPERATURE	80 °C
LOAD VSWR (NON DESTRUCTIVE)	3:1

TYPICAL OPERATION

Frequency	2450 MHz
Output Power	31.5 kW
Driving Power	100 mW
Power Gain	55 db
Beam Voltage	22.5 kVdc
Beam Current	2.66 Adc
Body Current	50 mAdc
Efficiency	52.5 %
Electromagnet Current	16.5 Adc

For additional data or information regarding a specific application, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California.



5K70SH and H-226

EIMAC

Division of Varian

X602K

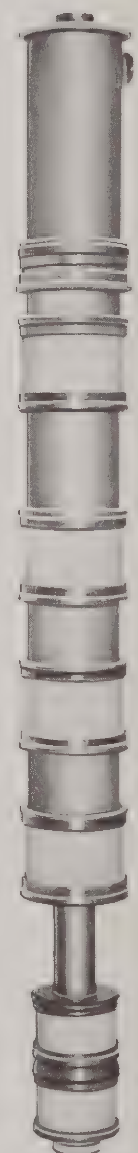
POWER AMPLIFIER L-BAND KLYSTRON

The EIMAC X602K is a four-cavity, magnetically focused, power-amplifier klystron designed for pulse service at frequencies from 375 to 500 megahertz. Under narrow-band conditions this tube will deliver a minimum pulse output power of 150 kilowatts at an average output power level of 75 kilowatts with a power gain of at least 45 decibels.

This klystron employs the EIMAC Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage.

All tuning is accomplished outside the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits external cavity loading for wide-band applications. For spares or replacements, only the basic klystron, without cavities, need be purchased.

EIMAC Klystron Amplifier Circuit Assembly H-142 has been designed for use with the X602K to cover the specified frequency range. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an EIMAC Air-System Socket. The H-142 Klystron Amplifier Circuit Assembly conforms generally to Military Environmental Specification MIL-E-4970A (USAF) and the general Military Specification MIL-E-4158B (USAF), for electronic ground equipment.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage (±5%)	11	volts
Current	47.5	amperes
Maximum Starting Current	100	amperes
Cathode: EMA, Unipotential		
Heating Time	5	minutes
Getter (Operating):		
Voltage (Nominal)	9.1	volts
Current	36	amperes
Power Gain: (Narrow-Band)	45	decibels
Minimum Pulse Output Power	150,000	watts
Average Output Power	75,000	watts
Frequency Range (H-142 Circuit Assembly)	375 to 500	megahertz

MECHANICAL

Operating Position	Vertical, cathode end up
RF Input Coupling	Type "N" coaxial fitting
RF Output Coupling	50-ohm, 6⅛" line
Weight (Tube Only)	196 pounds
Shipping Weight (Approximate)	410 pounds

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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MECHANICAL (continued)

Cooling: Water or 60% Ethylene Glycol solution and Forced Air	*Flow Rate*	*Pressure Drop*
Cathode (SK-1000 socket)	*50 cfm air	1 inch H_2O
Output Cavity	*50 cfm air	6 inches H_2O
Five Drift-Tube sections in series	10 gpm	23 psi
Collector	50 gpm	59 psi

MAXIMUM RATINGS

DC BEAM VOLTAGE	50	KILOVOLTS
AVERAGE BEAM CURRENT	5	AMPERES
PULSE BEAM CURRENT	9	AMPERES
DC FOCUS ELECTRODE VOLTAGE	—1000	VOLTS
PULSE BODY CURRENT	250	MILLIAMPERES
PULSE MODULATING ANODE VOLTAGE	50	KILOVOLTS
COLLECTOR DISSIPATION	170	KILOWATTS
SEAL TEMPERATURES	175	DEGREES C

TYPICAL OPERATION

(Narrow-Band, Pulse Amplifier in H-142 Magnetic Circuitry)

Frequency	390	megahertz
Pulse Output Power	155	kilowatts
Average Output Power	34	kilowatts
Drive Power	3.0	watts
Pulse Power Gain	47	decibels
Pulse Input Power	346	kilowatts
Average Input Power	76	kilowatts
DC Beam Voltage	45	kilovolts
Pulse Modulating Anode Voltage	45	kilovolts
Average Beam Current	1.69	amperes
Pulse Beam Current	7.7	amperes
Pulse Beam Efficiency	44.8	percent
DC Body Current	40	milliamperes
Focus Electrode Voltage	—400	volts
Duty	22	percent

*At Sea Level with 20°C inlet air temperature.

For additional data or information regarding a specific application, write to High Power Microwave Marketing, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California.

EIMAC

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TABLE OF CONTENTS

VOLUME II

* Divider Sheets Not Available

Effective Date 5-15-66

EIMAC

A Division of Varian Associates

Tentative Data

EM1010

TRAVELING WAVE TUBE

4.0 to 8.0 GHz
1 Watt Min.
60 db Gain

TENTATIVE DATA FOR EIMAC EM1010 TRAVELING WAVE TUBE

The EIMAC EM1010 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM1010 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 1 watt CW over the frequency range of 4.0 to 8.0 GHz with a nominal small signal gain of 60 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of +85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Saturated Output Power	1 watt
Frequency Range	4.0 to 8.0 gigahertz
Input and Output Impedence	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

DC Beam Voltage*	2600 volts
DC Focus Electrode Voltage*: Negative with respect to Cathode	40 volts
DC Cathode Current	30 milliamperes

Printed in U.S.A.

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigahertz
Minimum Output Power	1.0 watt
Small Signal Gain	60 decibels
DC Beam Voltage*	2550 volts
DC Cathode Current	28 milliamperes
DC Focus Electrode Voltage*	—30 volts
DC Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM1010 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ±5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ±1 per cent to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ±2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif.

ENVIRONMENTAL

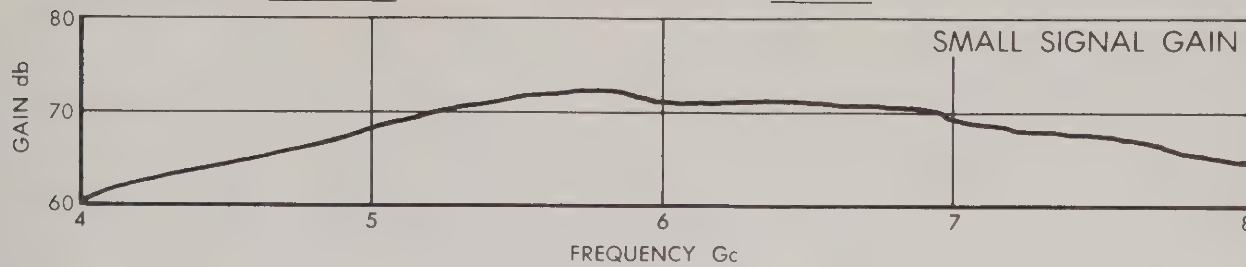
The EM1010 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

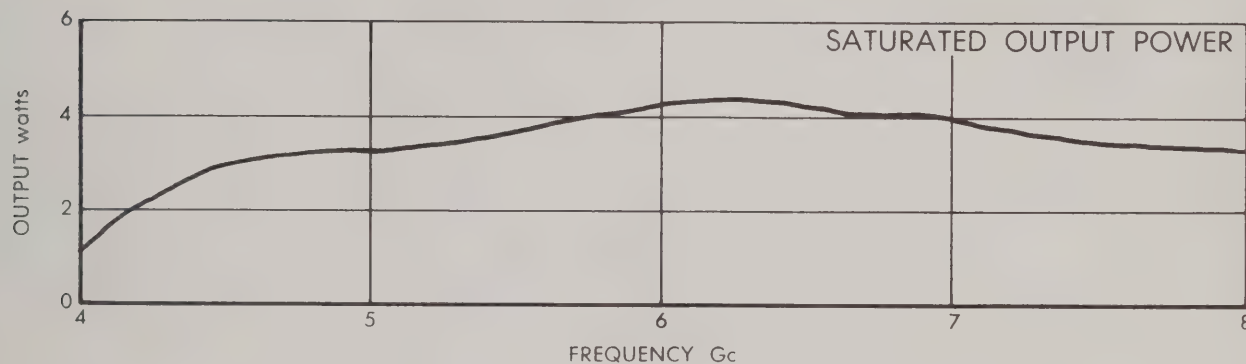
Vibration	10 g to 2000 Hz (Curve A of Proc. XII, MIL-E-5272C)
Shock	25 g, 11 ±1 ms
Acceleration	Sustained, 25 g's
Temperature	–54°C to +85°C
Altitude	70,000 ft.

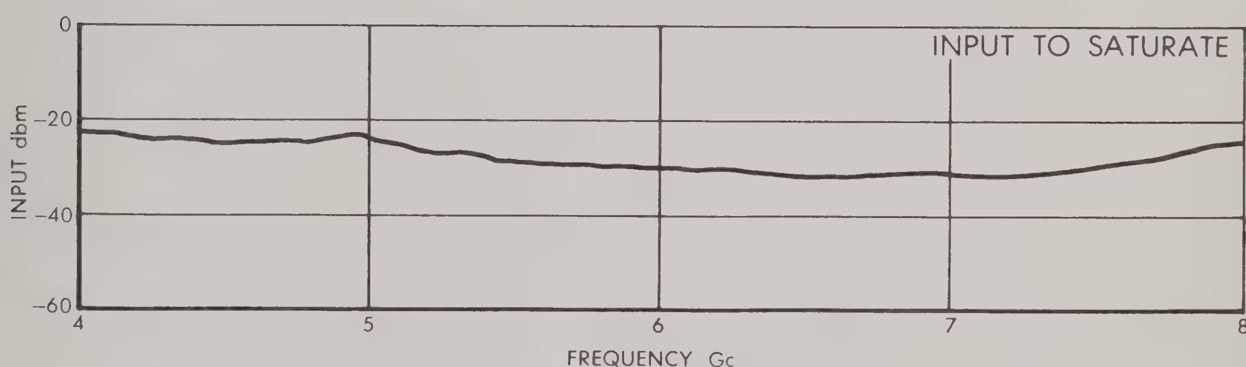
Note: This data should not be used for final equipment design.

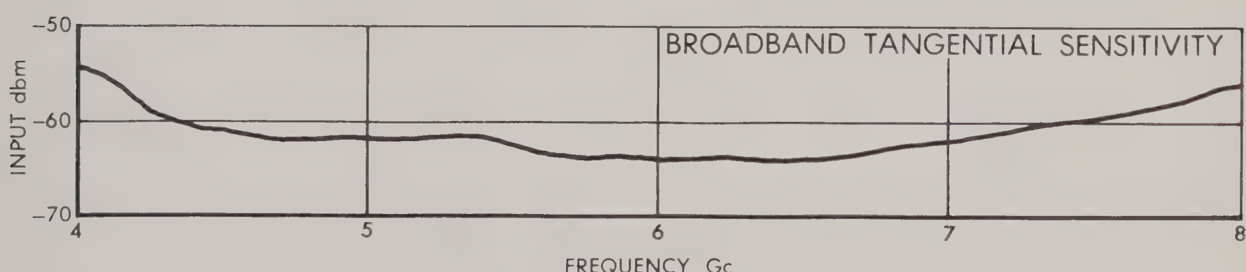
EM-1010 TYPICAL OPERATING CHARACTERISTICS

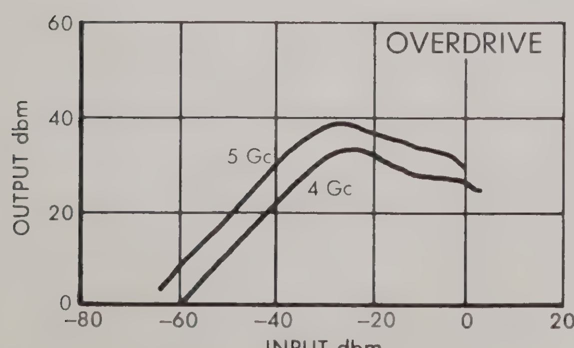
ANODE VOLTAGE	2550 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURRENT	28 mAdc	FILAMENT VOLTAGE	6.3 V

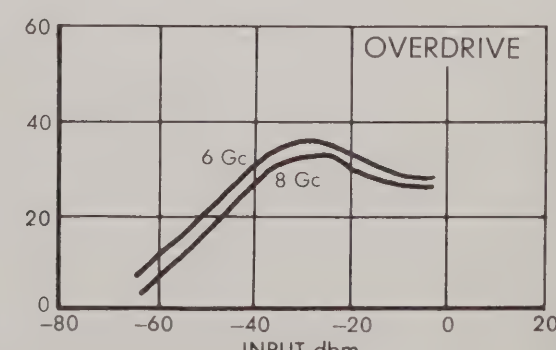








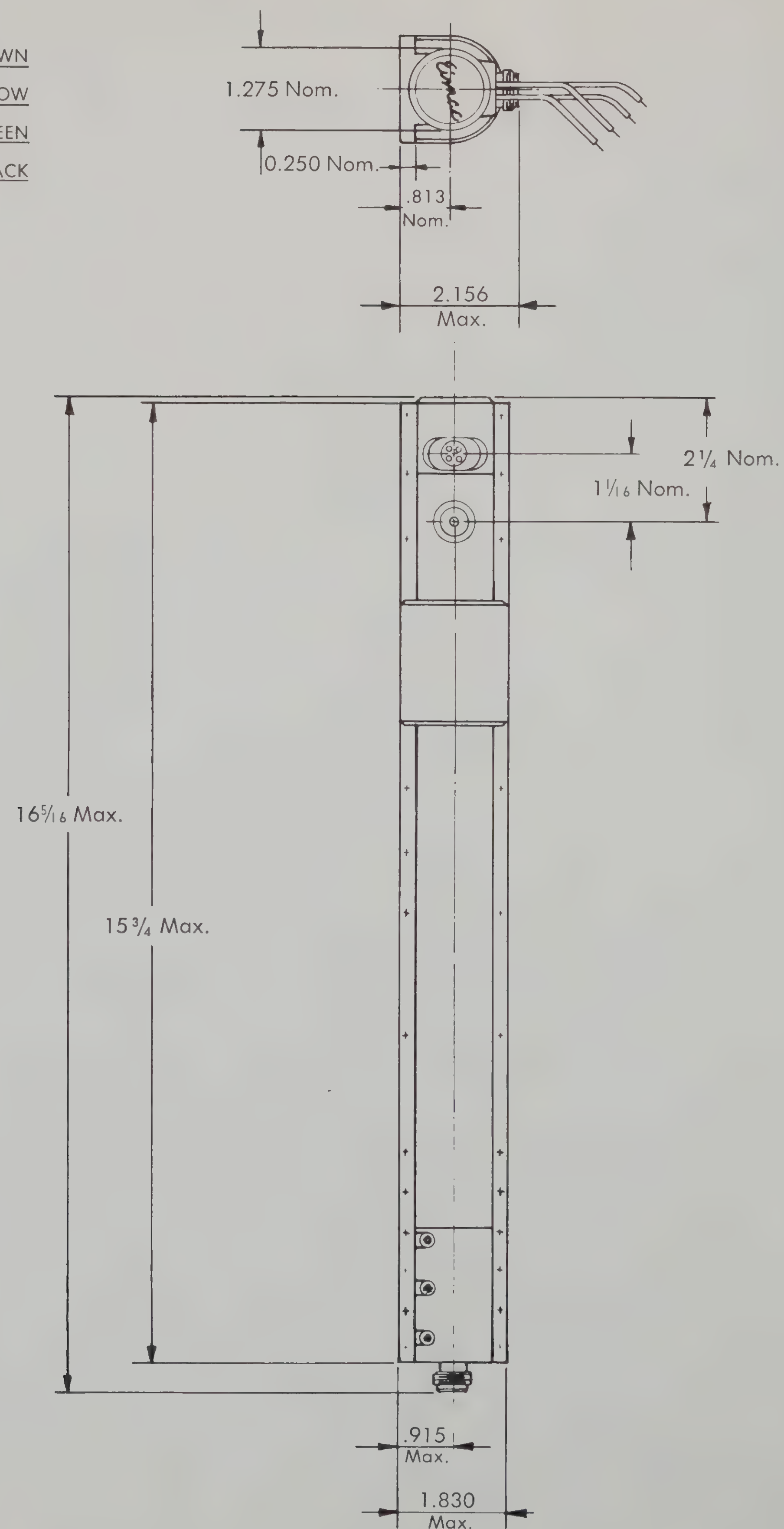




EM-1010

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



Tentative Data

EM1046

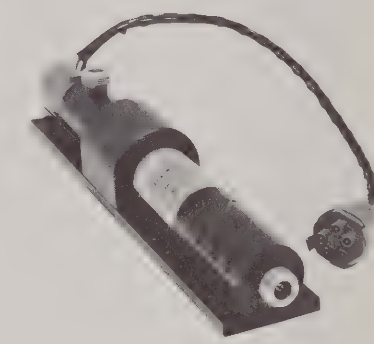
TRAVELING WAVE TUBE

8.0 to 12.0 GHz
1 Watt Min.
30 db Gain

EIMAC

A Division of Varian Associates

TENTATIVE DATA FOR EIMAC EM1046 TRAVELING WAVE TUBE



The EIMAC EM1046 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of 1 watt throughout the frequency range of 8.0 to 12.0 gigahertz with a nominal small signal gain of 30 decibels. The EM1046 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the EM1046 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	—50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	8.0 to 12.0 gigahertz
Input and Output Impedence	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

DC Beam Voltage*	3000 volts
DC Focus Electrode Voltage*:	
Negative with respect to Cathode	40 volts
DC Cathode Current	25 milliamperes

Printed in U.S.A.

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigahertz
Minimum Output Power	1.0 watt
Small Signal Gain	30 decibels
DC Beam Voltage*	2950 volts
DC Cathode Current	23 milliamperes
DC Focus Electrode Voltage*	—30 volts
DC Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM1046 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ±5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ±1 per cent to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ±2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif.

ENVIRONMENTAL

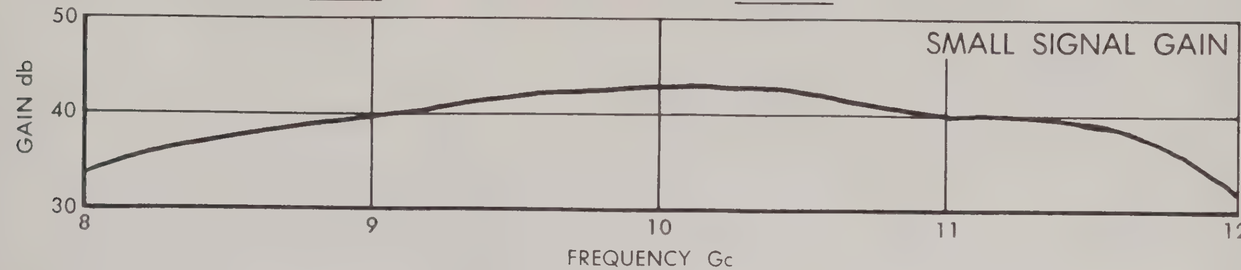
The EM1046 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

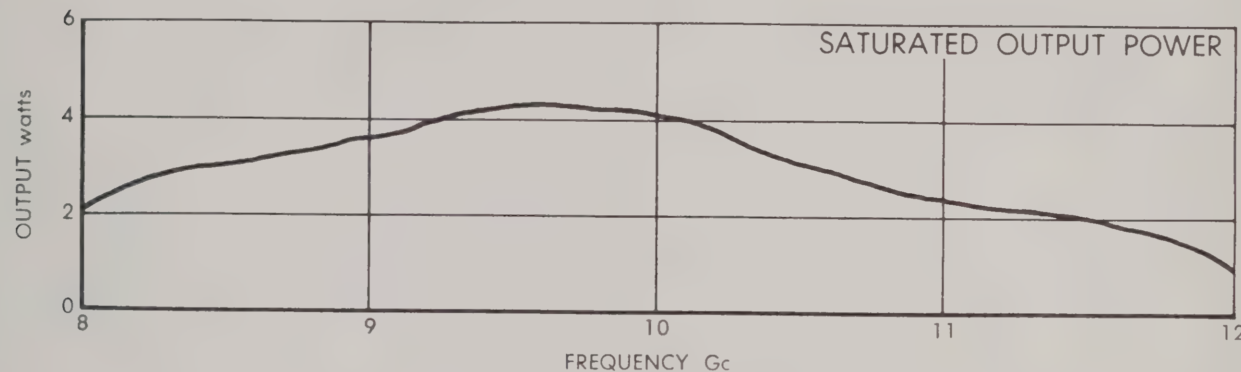
Vibration	10 g to 2000 Hz (Curve A of Proc. XII, MIL-E-5272C)
Shock	25 g, 11 ±1 ms
Acceleration	Sustained, 25 g's
Temperature	–54°C to +85°C
Altitude	70,000 ft.

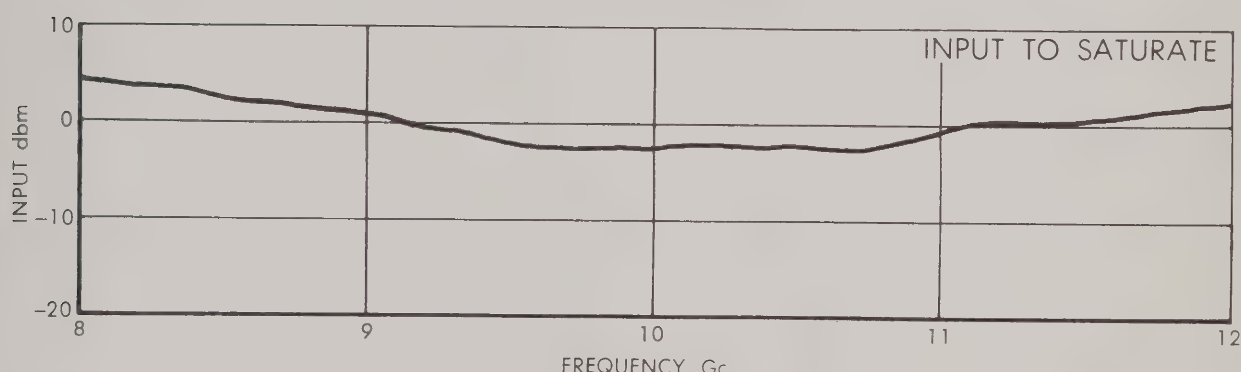
Note: This data should not be used for final equipment design.

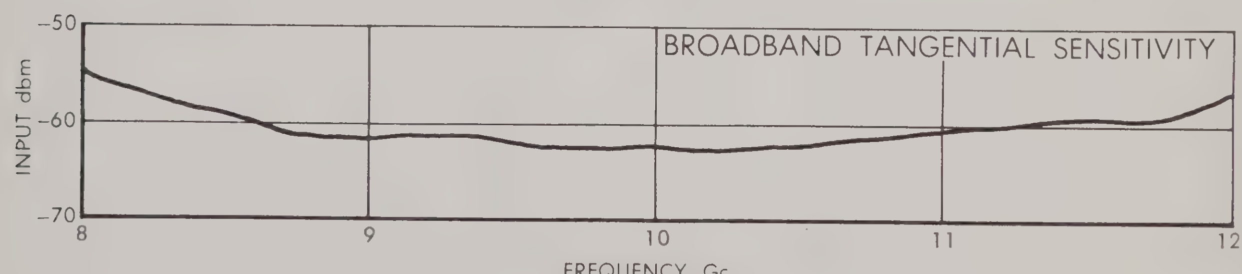
EM-1046 TYPICAL OPERATING CHARACTERISTICS

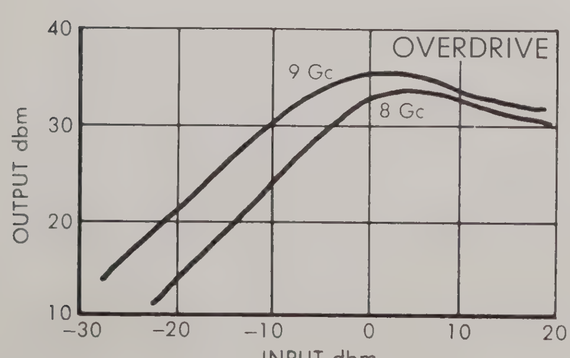
ANODE VOLTAGE 2950 Vdc
CATHODE CURENT 23 mAdc
FOCUS VOLTAGE −30 Vdc
FILAMENT VOLTAGE 6.3 Vac

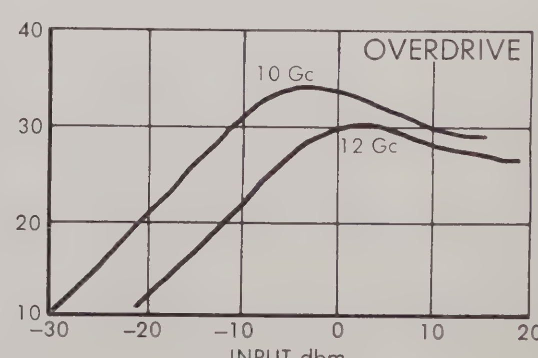








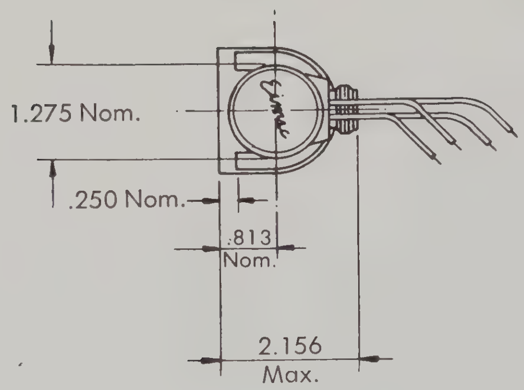


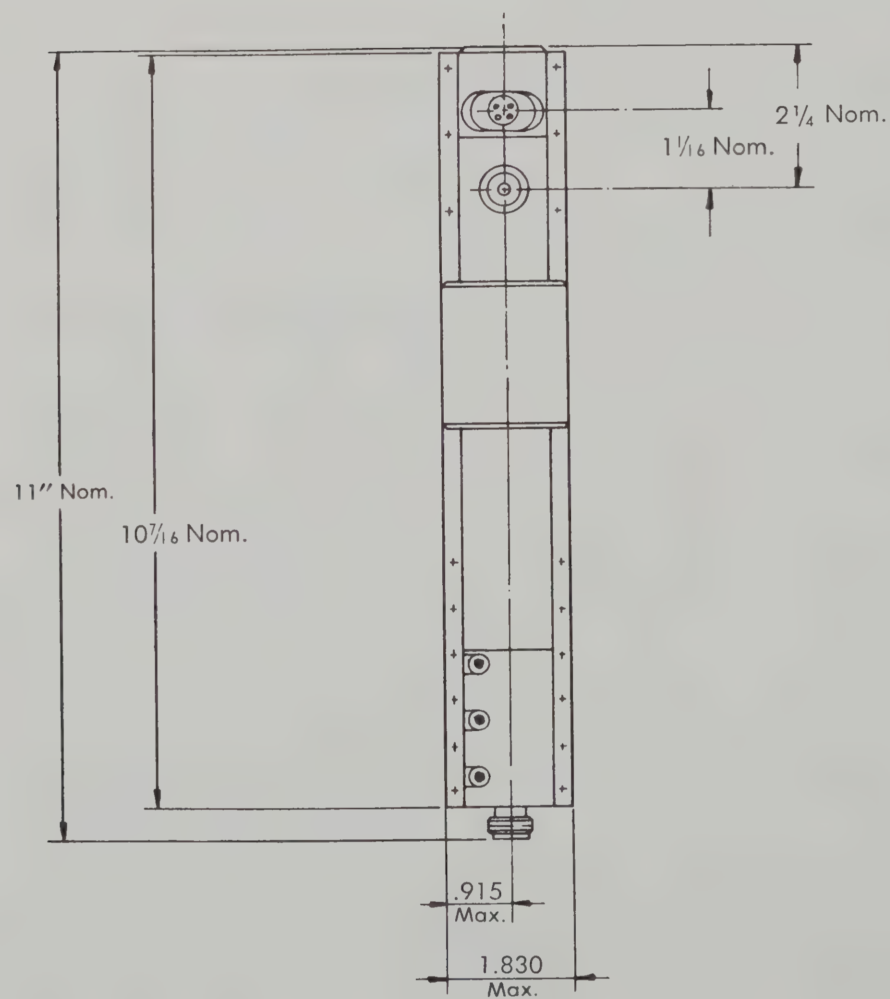


EM-1046

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EIMAC
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Tentative Data

EM1051

TRAVELING WAVE TUBE

8.0 to 12.0 GHz
3 Watts Min.
30 db Gain

TENTATIVE DATA FOR EIMAC EM1051 TRAVELING WAVE TUBE

The EIMAC EM1051 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM1051 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 3 watts CW over the frequency range of 8.0 to 12.0 GHz with a nominal small signal gain of 30 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of +85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated	
	Minimum Heating Time	60 seconds
Heater:	Voltage	6.3 volts
	Current	0.6 amperes
Noise Figure		25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)		—50 dbm
Minimum Saturated Output Power		3 watts
Frequency Range		8.0 to 12.0 gigahertz
Input and Output Impedence		50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

DC Beam Voltage*	3500 volts
DC Focus Electrode Voltage*: Negative with respect to Cathode	50 volts
DC Cathode Current	30 milliamperes

Printed in U.S.A.

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigahertz
Minimum Output Power	3.0 watts
Small Signal Gain	30 decibels
DC Beam Voltage*	3300 volts
DC Cathode Current	28 milliamperes
DC Focus Electrode Voltage*	—40 volts
DC Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM1051 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ±5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ±1 per cent to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ±2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif.

ENVIRONMENTAL

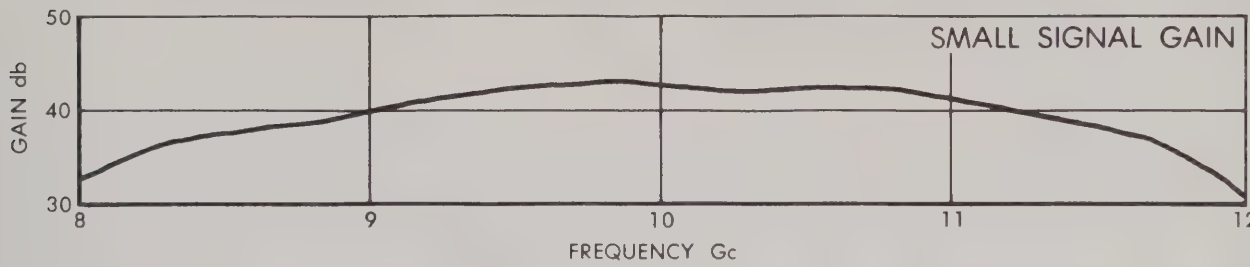
The EM1051 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

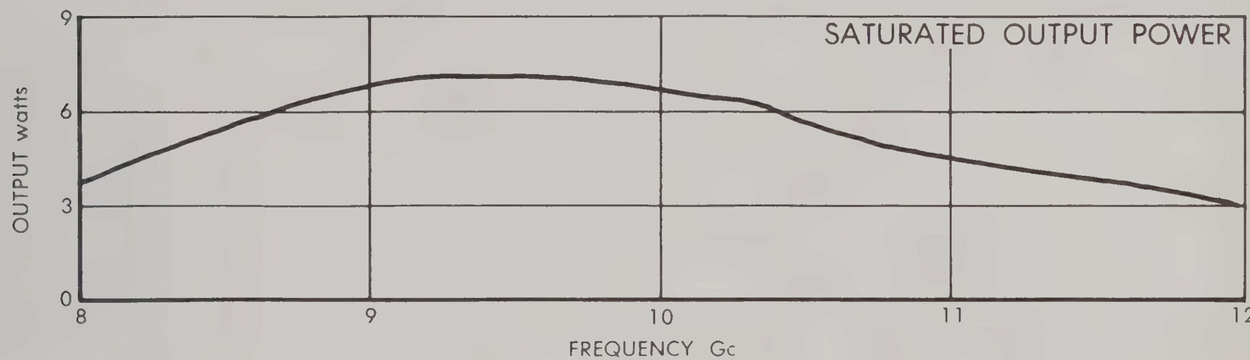
Vibration	10 g to 2000 Hz (Curve A of Proc. XII, MIL-E-5272C)
Shock	25 g, 11 ±1 ms
Acceleration	Sustained, 25 g's
Temperature	–54°C to +85°C
Altitude	70,000 ft.

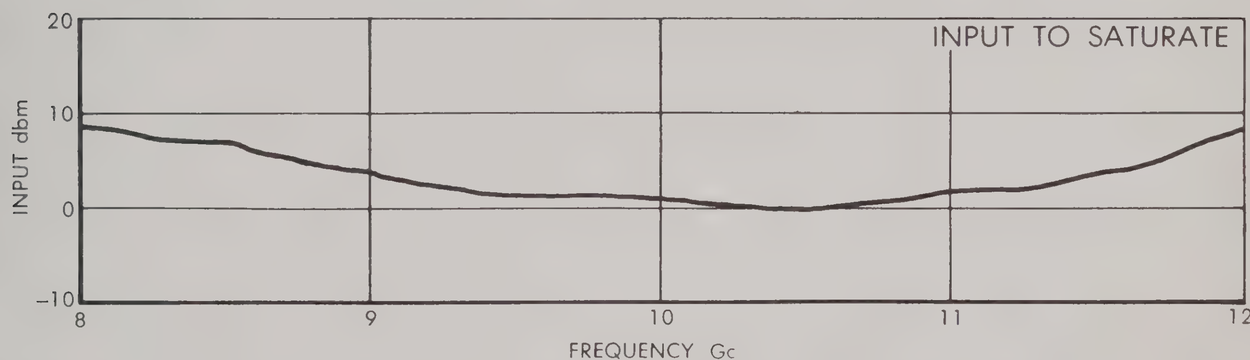
Note: This data should not be used for final equipment design.

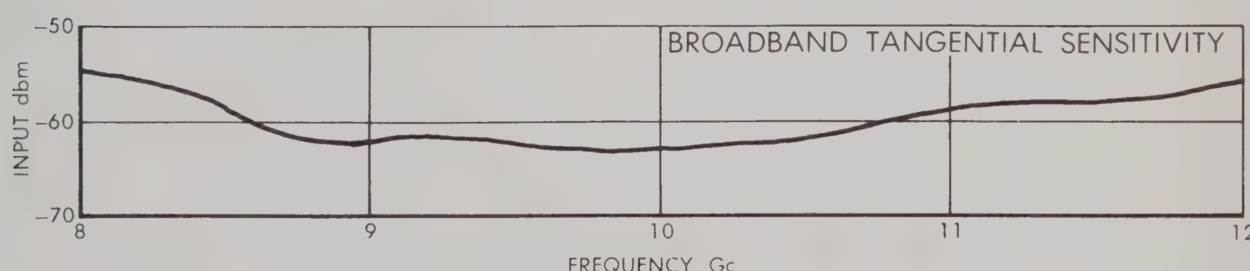
EM-1051 TYPICAL OPERATING CHARACTERISTICS

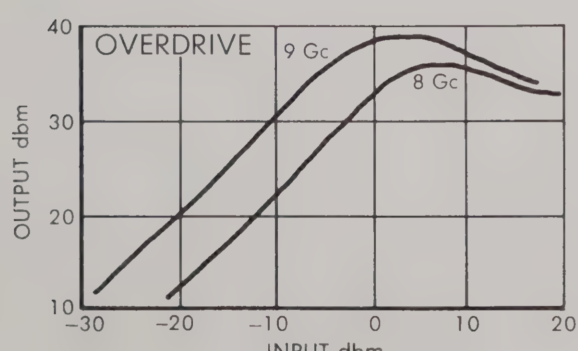
ANODE VOLTAGE 3300 Vdc
CATHODE CURRENT 28 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 Vac

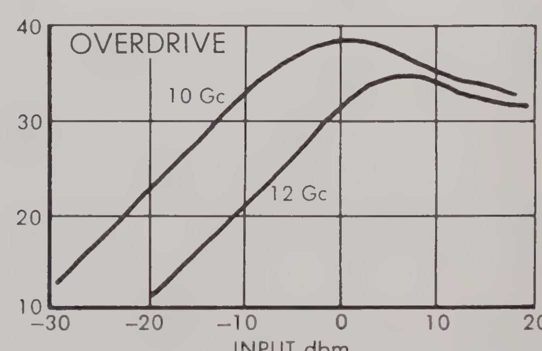








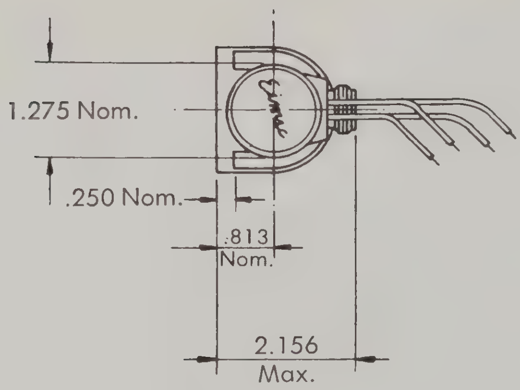


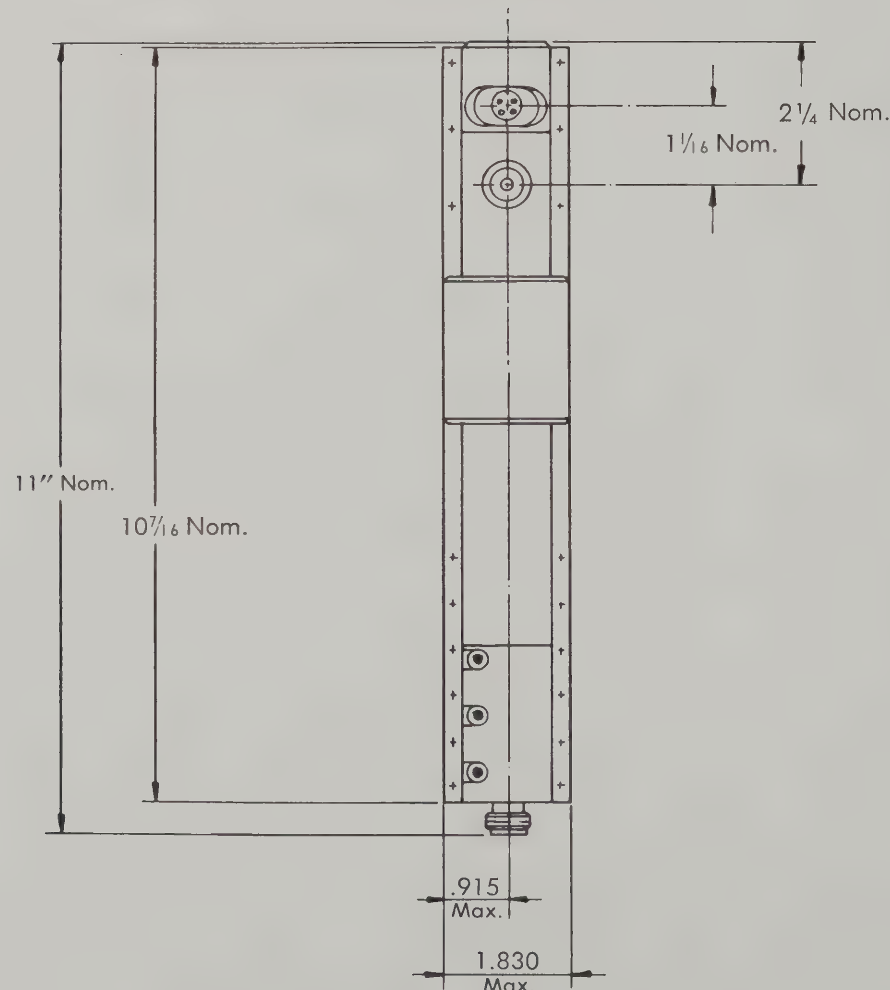


EM-1051

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EIMAC

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EM4504
EM4537
AMPLIFIER SYSTEM
2200 - 2300 MHz
1435 - 1600 MHz

These modular amplifier systems are recommended for medium power aerospace telemetry transmission. They provide at least 10 db gain in the 2200-2300 MHz or 1435-1535 MHz telemetry bands, when driven by a 1-2 watt exciter. The system includes an EM4590 power supply, plus an L-band (EM4539) or S-band (EM4596) cavity amplifier. Full power output is provided, even in the severe environment of missile launch. These modular units provide maximum flexibility in system packaging. A single package containing both the amplifier and the power supply is also available, on special order. All modules are conduction cooled, and can be operated continuously at heat sink temperatures from –54°C to +95°C. They are hermetically sealed, for operation at any altitude.

AMPLIFER MODULE

Model EM4596 is used for 2200-2300 MHz; EM4539 is used for 1435-1600 MHz. These cavity amplifiers provide at least 10 db gain, using a rugged, frequency-stable ceramic planar triode. All connectors and tuners are accessible on one surface. A low pass filter, for harmonic suppression, is included. EM4596 is 3¾″ x 2½″ x 1½″ and weighs 0.95 lbs.; EM 4593 is 4″ x 2½″ x 1½″ and weighs 1.1 lbs. (dimensions include all protusions). For further details, refer to the data sheets for these units.

POWER SUPPLY

The dc-dc converter, included in the amplifier system, is Model EM4590. This is a solid state unit which provides regulated plate and heater voltages, operating from a 28 Vdc primary source. All components are used well below their maximum ratings. Size is 1.7″ x 4.2″ x 5.5″; weight is 2.5 lbs. For further details, refer to the EM4590 data sheet.

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

 Printed in U.S.A.

CHARACTERISTICS

ELECTRICAL

Frequency,[1] continuously tunable, EM4504	2200-2300 MHz
EM4537	1435-1600 MHz
RF power[2] output (with 2 watts drive), minimum	20 Watts
RF power[2] output (with 1 watt drive), minimum	12 Watts
Input Signals	All standard FM telemetry signal formats, per IRIG 106-65
Bandwidth, Minimum, 3 db points	10 MHz
Gain, Minimum	10 db
Load Impedance, Nominal	50 Ohms
VSWR, Maximum, for full rated output	1.5:1
without damage	3:1
Harmonic Suppression, Minimum (2nd, 3rd & 4th)	60 db
Warm-up Time	3 Minutes
Input Voltage[3]	28^{+8}_{-4} Vdc
Overvoltage, Maximum	43 Vdc
Input Transients, Maximum	80 Volts for 20 Microseconds
Input Ripple, Maximum	3 V rms, DC-20 KHz, superimposed on 24-32 Vdc input
Interference	Meets MIL-I-6181D
Efficiency, DC-RF Conversion, Minimum	17.5%

MECHANICAL

	Size	*Weight*
Power Supply Module	1.7″ x 4.2″ x 5.5″	2.5 lbs.
S-band Cavity Amplifier Module	3.75″ x 2.5″ x 1.5″	0.95 lbs.
L-band Cavity Amplifier Module	4″ x 2.5″ x 1.5″	1.1 lbs.
Mounting	To Heat Sink (not included)	
Cooling	Conduction	
Connectors: RF input and output	OSM Female	
Primary power input	Bendix JT07H-8-3P	
Power supply module output	Deutsch DTK07H-12-8P	
Cavity Amplifier module input	Deutsch DM5300-3P-643	

ENVIRONMENTAL

Temperature, Heat Sink (for continuous operation)	–54°C to +95°C
Altitude (3 hour duration)	Any
Vibration 20 g peak to 2 KHz, Curve E, Fig. 514-3	MIL-STD-810
0.3 G^2/Hz Random, Curve F, Fig. 514-4	MIL-STD-810
20 g peak to 2 KHz, Category II	MIL-E-5400
Other	Per MIL-E-5400

FOOTNOTES

[1]Also available with similar performance characteristics for other frequencies in the 500-2500 MHz range.

[2]Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions. See EM4539 and EM4596 data sheets for typical performance curves.

[3]Power supplies for operation from other primary sources are also available.

Eimac®

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SAN CARLOS, CALIFORNIA

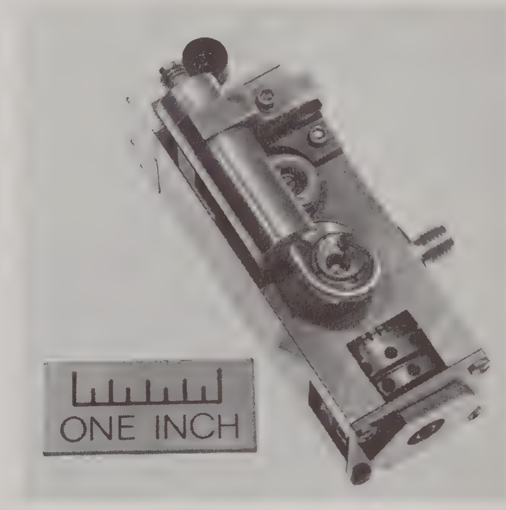
EM4522-5
EM4522-6
EM4538-2
EM4538-5
EM4591

CAVITY OSCILLATORS

1435 - 1540 MHz
1700 - 1850 MHz
2200 - 2300 MHz

These oscillators are recommended for use in UHF/microwave telemetry transmitters and aerospace television transmitters. They are precisely tuned over the specified ranges by three easy adjustments. Power output and frequency are highly stable under severe environmental conditions, including shock and vibration of missile launch. Modulation is achieved by varying the voltage applied to a varactor diode in the anode cavity. Modulation is linear over a wide range of frequency deviation. High rf efficiency is another important advantage of these oscillators. These are very compact units, shaped for maximum packaging efficiency. Cooling is by conduction to the transmitter case. All models use rugged ceramic-metal planar triodes.

Dc-dc converters are available from EIMAC to operate these oscillators from 28Vdc.



EM4522-5 OSCILLATOR

CHARACTERISTICS

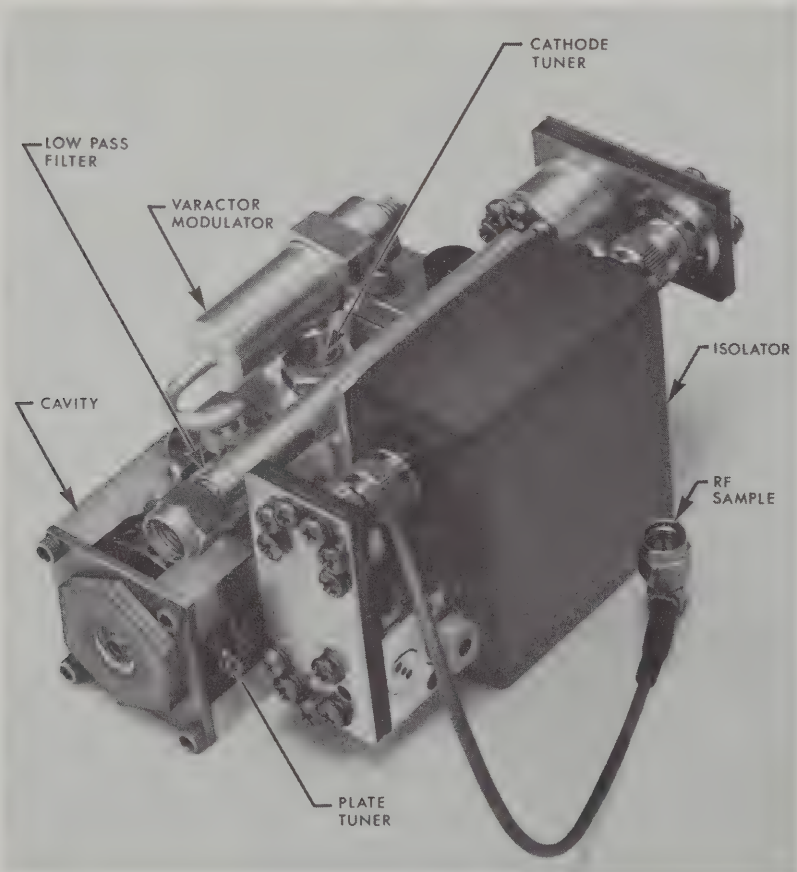
ELECTRICAL	EM4522-5	EM4522-6	EM4538-2	EM4538-5	EM4591
Tuning Range, MHz[1]	2200-2300	2200-2300	1435-1540	1435-1540	1700-1850
rf Power Output,[3] Watts, CW	2	10	13	3	2.5
Frequency Stability, MHz	±2.5	±2.5	±2.5	±2	±2
Power Supply Requirements:					
Anode Voltage, Volts, Max.	165	240	240	165	165
Anode Current, mA, Max.	70	130	130	70	70
Control Grid	←		Self Bias		→
Heater Voltage, Volts	6.0	5.6	5.6	6.0	6.0
Heater Current, mA, Max.	400	540	540	400	400
Suggested EIMAC Power Supply Model	EM4589	PS4700	PS4700	EM4589	EM4589
Load Impedance, Ohms, Nominal	←		50		→
Modulation	←		Any IRIG 106-65 Format		→
Modulation Linearity:					
500 KHz peak-to-peak deviation, %	←		1		→
3 MHz peak-to-peak deviation, %	←		2.5		→
6 MHz peak-to-peak deviation, %	←		5		→
Modulation Frequency Response, 0-2 MHz, db	←		0.5		→
VSWR, Maximum for rated output	←		1.2:1		→
Maximum without damage	←		3:1		→
Warm-up time	←		90 Seconds		→
MECHANICAL					
Mounting	←		Bolts to Heat Sink		→
Dimensions	←		See Drawing		→
Weight, pounds	←		0.4		→
Cooling	←		Conduction to Heat Sink		→
Connector, rf output	←		OSM		→
Modulation Input	←		OSSM		→

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

ENVIRONMENTAL

Temperature (Heat Sink)	–54° to +85°C
Vibration[2] (MIL-STD-810, Fig. 514-3 Curve D)	15 g Peak to 2 KHz
Shock[2] (MIL-STD-810 Method 516, Procedures I and V, half sine)	15 g for 11 milliseconds
Sustained Acceleration	30 g for 5 minutes

[1]Other ranges available on special order.
[2]Electrical performance is as specified, under these environmental conditions. More severe conditions can be withstood without damage.
[3]Higher power oscillators available on special order.



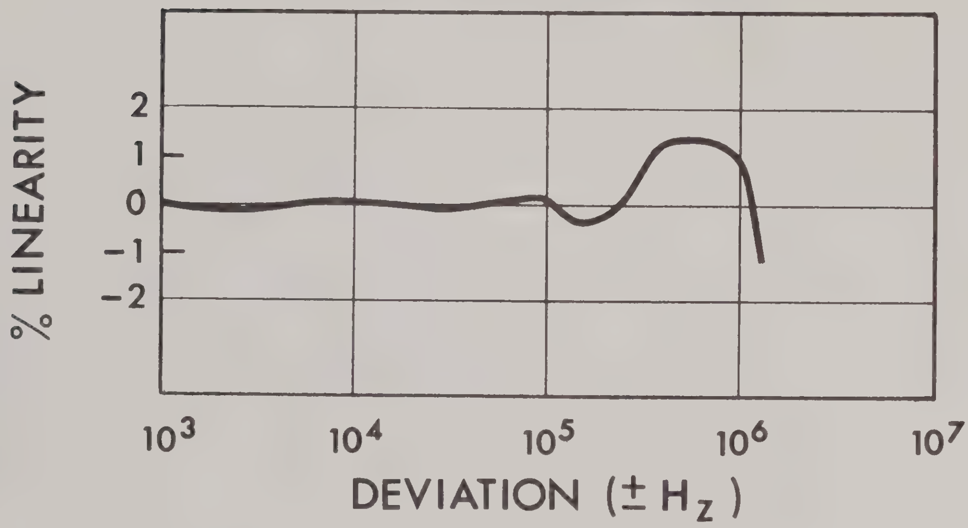
MODEL EM4522-5 OSCILLATOR WITH ACCESSORIES

Complete rf power source packages are also available from EIMAC. The package shown here includes a three-port terminated circulator, low pass filter, modulation input choke and cabling.

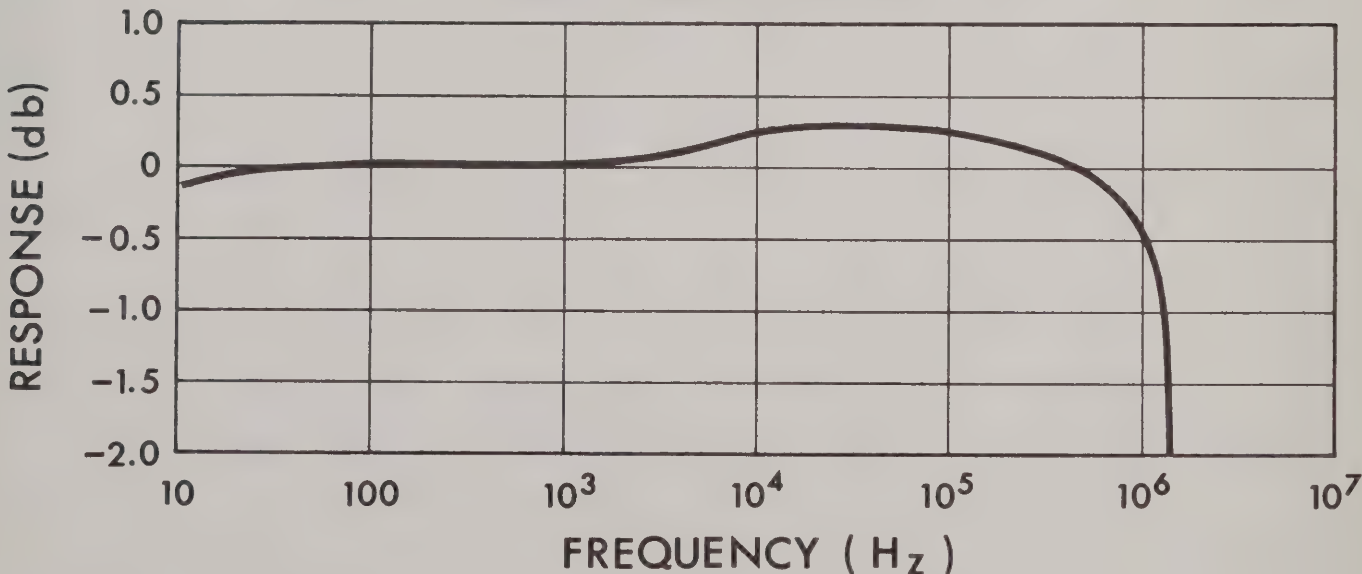
Dc-dc converters are available from EIMAC to operate any EIMAC oscillator or amplifier from 28 Vdc. These power supplies feature compact, light weight design, particularly suited for use in aerospace systems. All components are solid state. The package is conduction cooled. Operation during the shock and vibration of missile launch is satisfactory. RF interference is within limits of the applicable MIL specifications.

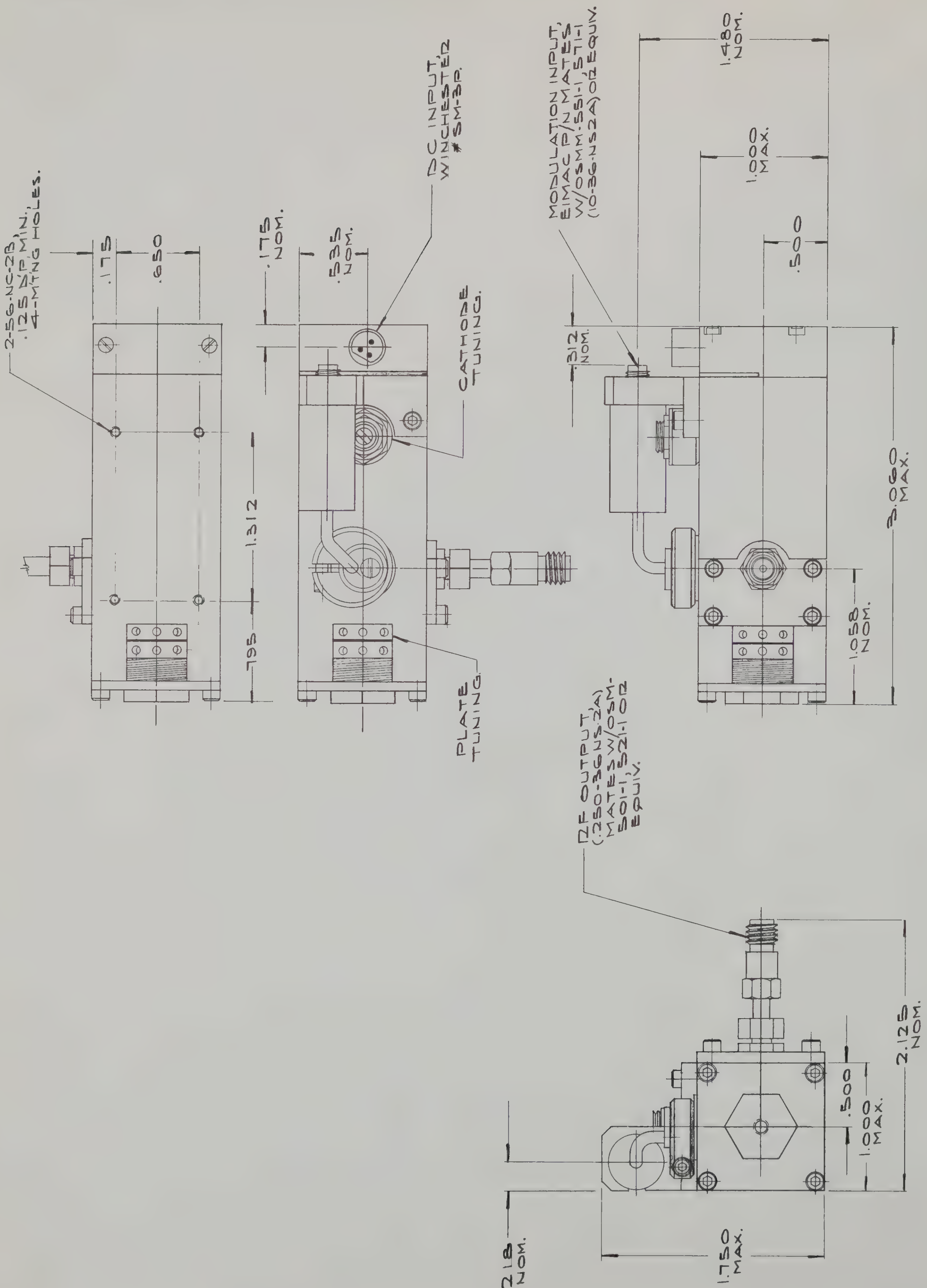
Power supplies for operation from 400 CPS primary supply are available on special order.

TYPICAL MEASURED MODULATION LINEARITY
MODEL EM4522-5 OSCILLATOR



TYPICAL MEASURED MODULATION FREQUENCY RESPONSE
MODEL EM4522-5 OSCILLATOR




2-56-NC-2B, .125 DP MIN, 4-MTNG HOLES.
.175
.650
.175 NOM.
.535 NOM.
DC INPUT, WINCHESTER #SM-3P.
CATHODE TUNING.
MODULATION INPUT, EIMAC P/N MATES, W/OSM-551-1, 5T1-1 (10-36-NS2A) OR EQUIV.
1.480 NOM.
1.000 MAX.
.500
.312 NOM.
3.060 MAX.
1.312
.795
1.058 NOM.
PLATE TUNING.
RF OUTPUT (.250-36NS-2A) MATES W/OSM-501-1, 521-1 OR EQUIV.
2.125 NOM.
.500
1.000 MAX.
.218 NOM.
1.750 MAX.

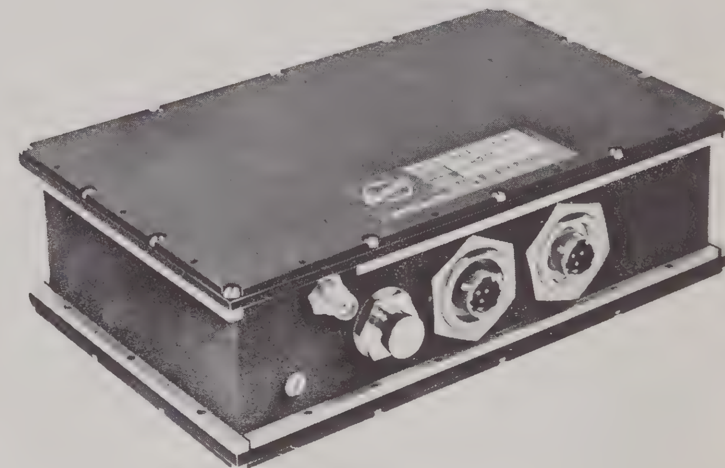
EIMAC

A Division of Varian Associates

EM4527
TELEMETRY TRANSMITTER

2200 - 2300 MHz
2 Watts

This EIMAC S-Band transmitter provides over 2 watts rf output with over 10% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. It is designed to operate during the severe shock and vibration of missile launch.



Model EM 4527 is a complete transmitter, including a pre-regulated DC-DC converter. All circuits are solid state, except the rf power oscillator, which is a single stage rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter package displaces less than 50 cubic inches, and weighs 4 pounds. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 2.2-2.3 GHz band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range —40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 MHz is accomplished at ±2.5% linearity, and ±300 KHz at ±0.5% linearity.

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	2200-2300 MHz
Power Output, CW Minimum	2 Watts
Frequency Accuracy	±0.001%
Frequency Stability[7]	±0.0025%
Carrier Deviation, Adjustable, peak-to-peak	2Mc/Volt to 30Kc/Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 Hz to 500 KHz
Flat within ±1 db	5 Hz to 800 KHz
Modulation Linearity, Deviation from B.S.L.,	
For ±300 KHz peak Deviation	±0.5%
For ±1.5 MHz peak Deviation	±2.5%
Incidental Frequency Modulation, Maximum	5 KHz rms deviation
AM, Maximum, due to environmental conditions	1%
due to ±300 KHz carrier deviation	1%
due to ±1.5 MHz carrier deviation	5%
Modulation Input Impedance, Minimum, 5 Hz to 800 KHz	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	700 mA
Primary Ripple, maximum, peak-to-peak from Dc to 20 KHz	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
Input current rise above nominal, due to fault,[3] maximum	130%
VSWR Maximum, any phase, for 2 watts output	1.5:1
for 1 watt output	5.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	500 hours

PACKAGING

Volume displaced	48 cubic inches
Dimensions, including mounting flanges	6.5"x 4.4"x 1.9"
Weight	4 pounds
Pressurization	30 psia
Cooling	Conduction through bottom plate to heat sink

ENVIRONMENTAL SPECIFICATIONS[4]

Temperature[5] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration (MIL-STD-810, Figure 514-3, Curve D)	15G peak to 2KHz
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/Hz
Air Induced Vibration	150 db above $2x10^{-4}$dynes/CM^2 from 150 to 2000 Hz, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration	30G for 5 minutes, three axes
Shock, per MIL-STD-810 Method 516, Procedures I and V,	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[6]	100G

[7] ±0.001% available on special order.

[6] Out-of-tolerance operation may occur during 100G shock.

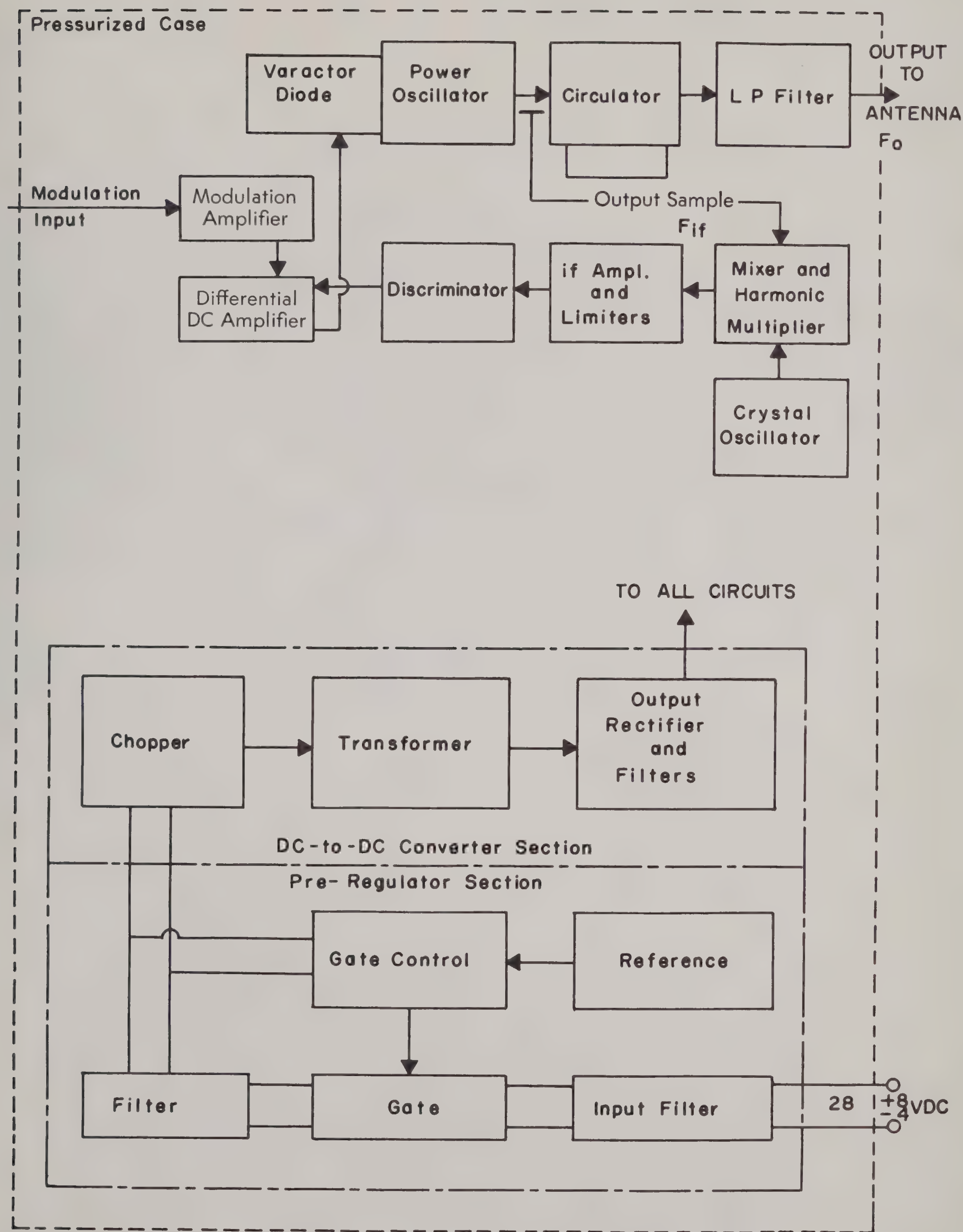
[5] Other ranges available on special order.

[4] Transmitter performs as specified, under any combination of environmental conditions.

[3] Any failure of transmitter (except at input terminals.)

[2] Under emergency conditions, full rf output is provided with primary power as low as 22 Vdc, but increased IFM and AM will occur.

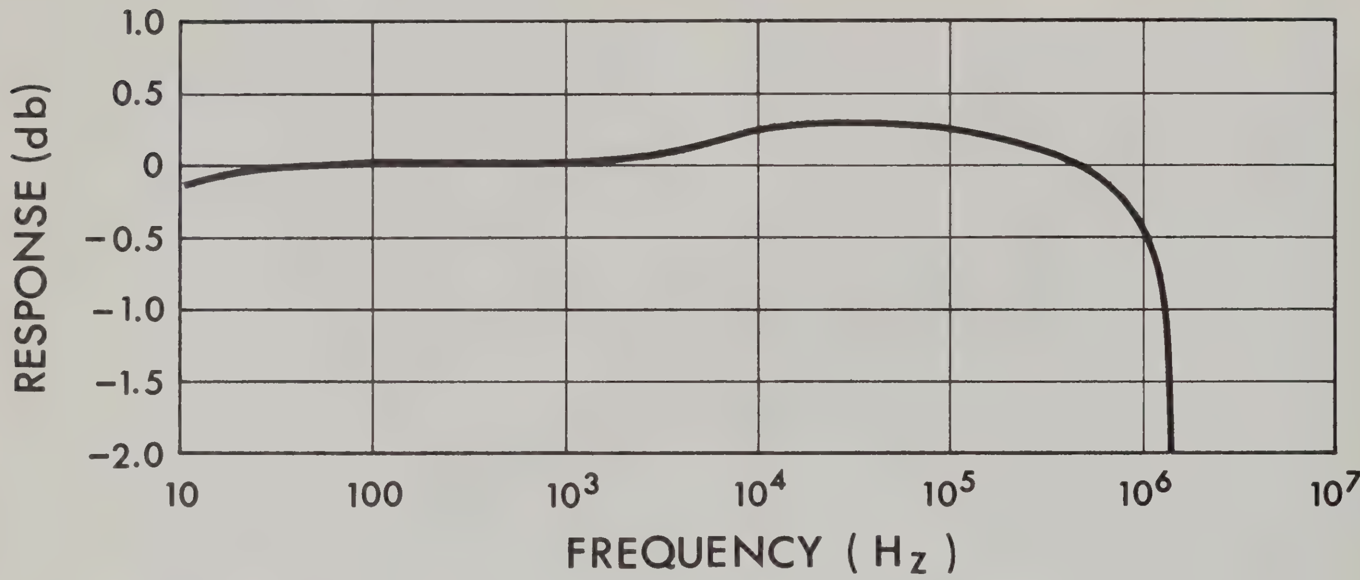
[1] Also available modified for modulation down to DC; and up to 2MHz.



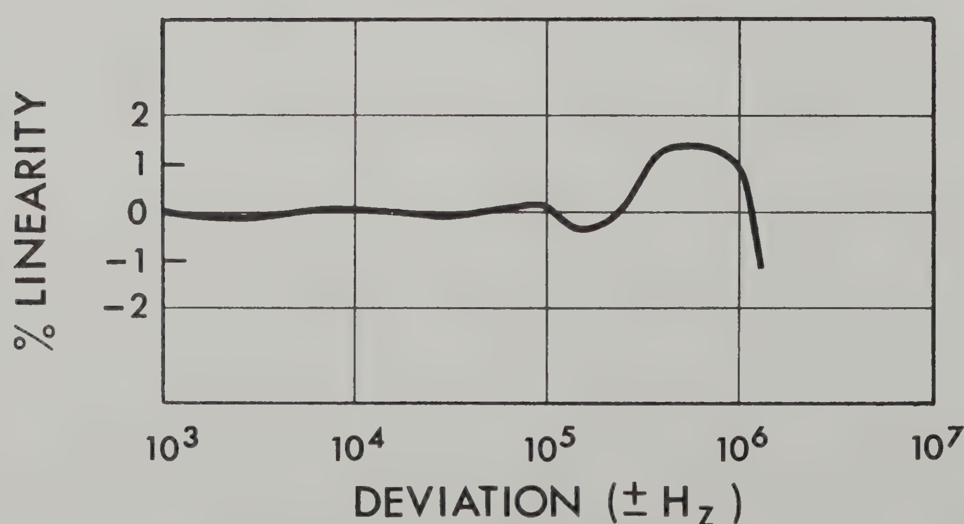
BLOCK DIAGRAM

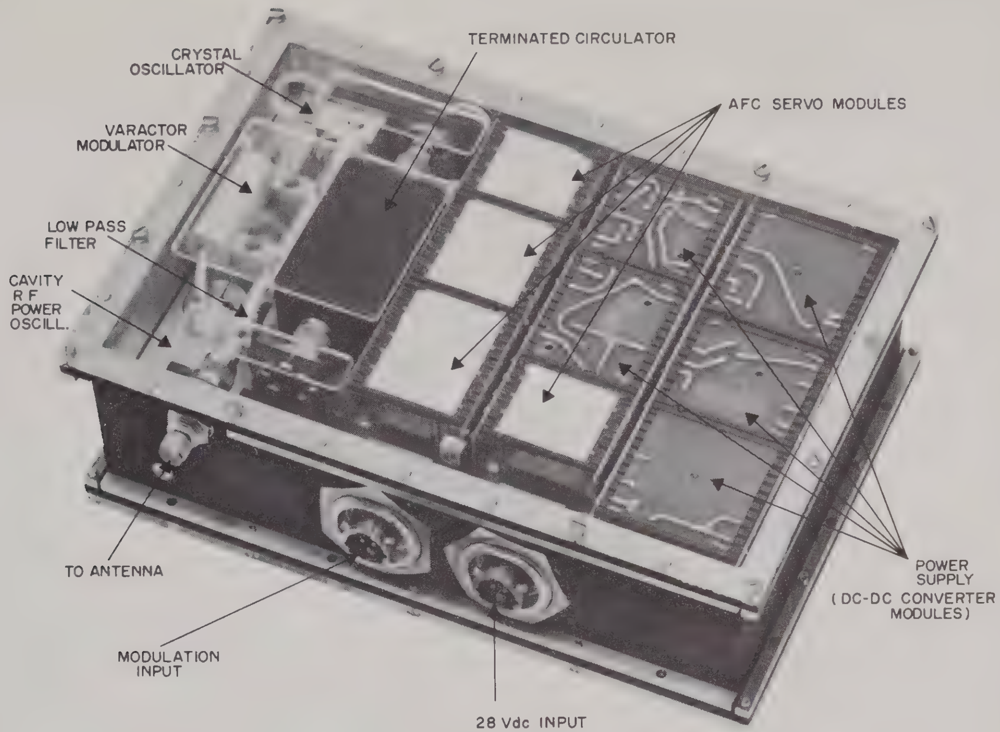
MODEL EM4527 2W S-BAND TELEMETRY TRANSMITTER

MODULATION FREQUENCY RESPONSE OF TRANSMITTER
EM4527, (TYPICAL)



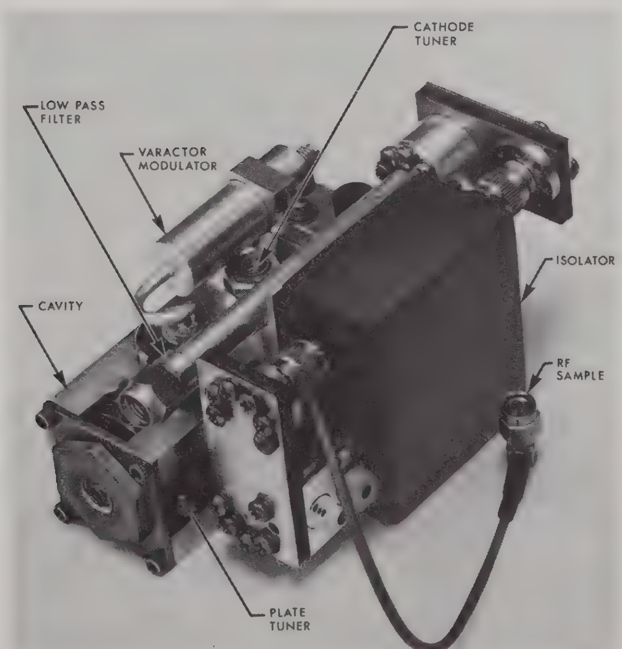
DEVIATION LINEARITY OF TRANSMITTER
EM4527, (TYPICAL)





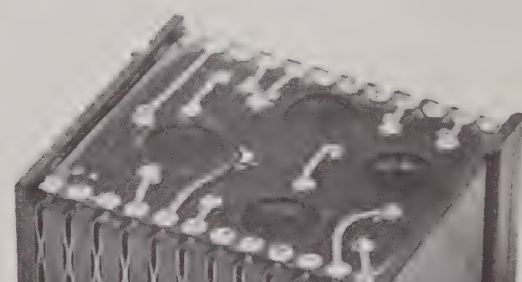
EM4527 TELEMETRY TRANSMITTER ASSEMBLY

Packaging of this transmitter is compact, yet all modules are easily accessible by removing top and bottom covers. The covers incorporate pressure seals and rfi gaskets.



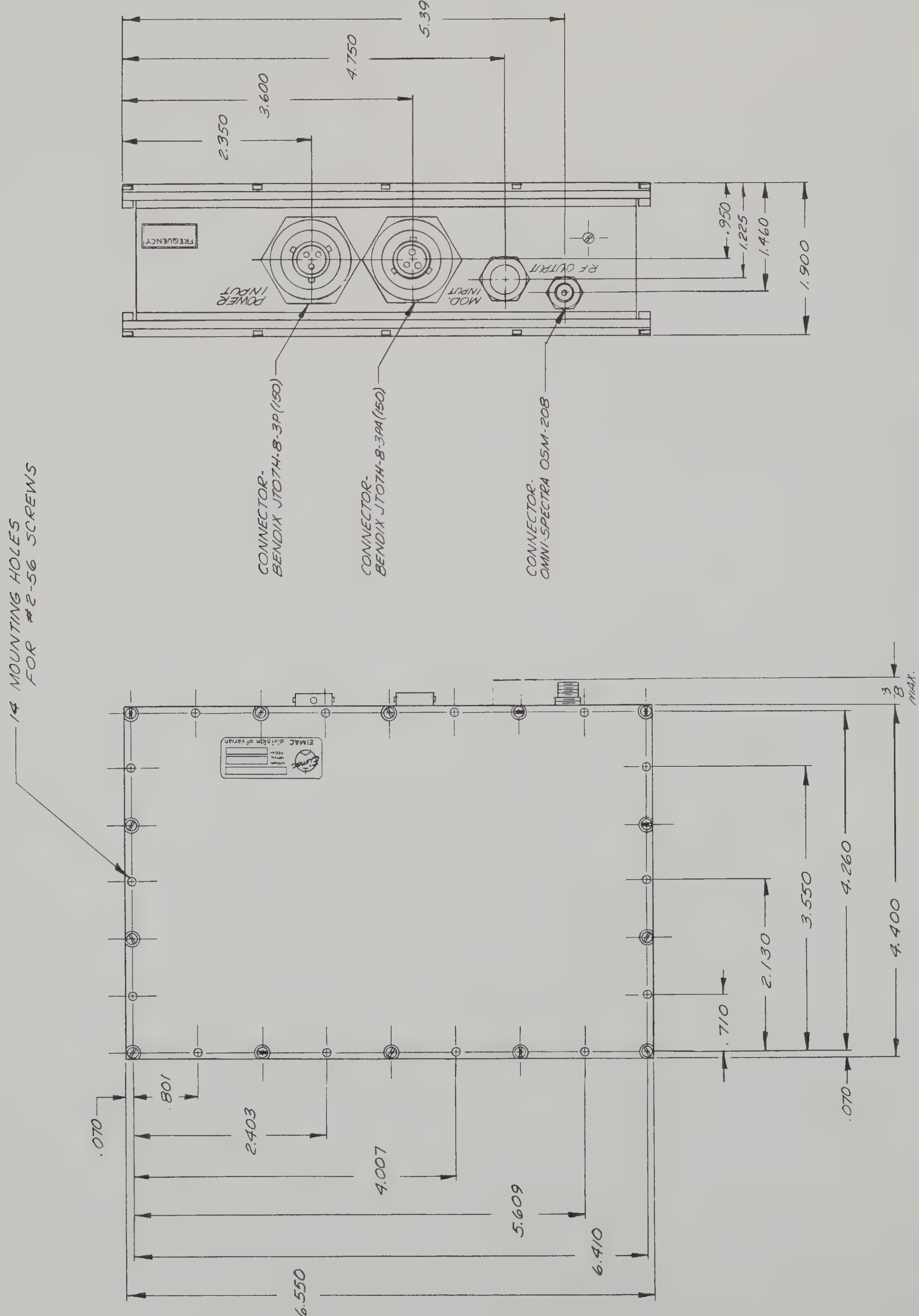
RF SECTION, EM4527 TRANSMITTER

The rf power oscillator provides over 2 watts, tunable 2.2-2.3 GHz. There is no output below 2.2 GHz. Harmonics are removed by a low pass filter. The ceramic planar triode in the oscillator is conduction cooled to the transmitter case.



TYPICAL PLUG-IN MODULE

Circuits use only high reliability components such as silicon planar transistors and are packaged in modular form. The modules are easily removable, and offer flexibility for future modification. The connector system provides four redundant contacts at each connection. Modules are encapsulated with a rigid high thermal conductivity compound for heat conduction and vibration protection.


5.390
4.750
3.600
2.350
.950
1.225
1.460
1.900
FREQUENCY
POWER INPUT
MOD. INPUT
RF OUTPUT
CONNECTOR-
BENDIX JT07H-8-3P(150)
CONNECTOR-
BENDIX JT07H-8-3PA(150)
CONNECTOR:
OMNI-SPECTRA OSM-208
14 MOUNTING HOLES
FOR #2-56 SCREWS
EIMAC division of varian
3/8 MAX.
4.400
4.260
3.550
2.130
.710
.070
.070
.801
2.403
4.007
5.609
6.410
6.550

Eimac®

EIMAC

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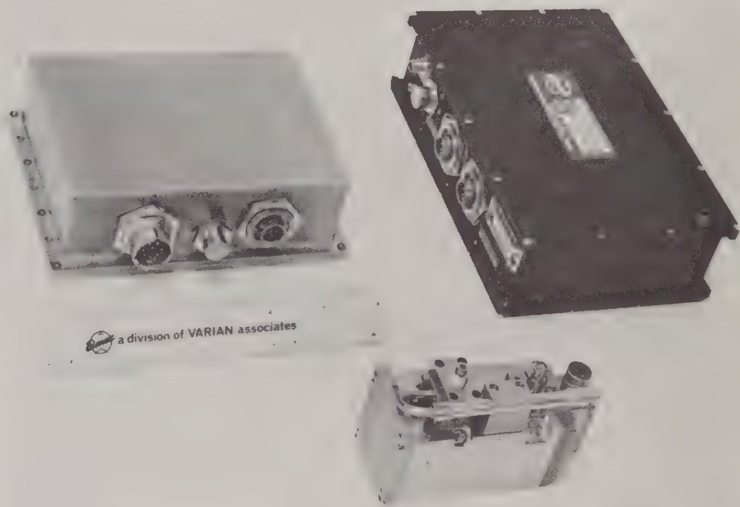
X4528

TELEMETRY TRANSMITTER

2200 - 2300 MHz
20 Watts

The EIMAC X4528 S-band transmitter is packaged in three modules, for maximum flexibility in system packaging. Output is over 20 watts, with over 13% overall efficiency, under all combinations of worst specified extremes of environment and primary power. X4528 operates satisfactorily in the severe environment of missile launch. Frequency change, if desired, is easily accomplished in the field.



Model X4528 is a complete transmitter. It includes an exciter, a power amplifier and a pre-regulated dc-dc converter. All circuits are solid state, except the rf power oscillator and the power amplifier; these use rugged ceramic planar triodes. RF is generated at the output frequency, and stabilized by a crystal-referenced AFC servo circuit. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the the 2.2-2.3 GHz band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by only two rf stages, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range —40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 Mc is accomplished at ±2.5% linearity, and ±300 Kc at ±0.5% linearity.

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	2200-2300 MHz
Power Output, CW Minimum	20 Watts
Frequency Accuracy	±0.001%
Frequency Stability[6]	±0.0025%
Carrier Deviation, Adjustable, peak-to-peak	2 MHz Volt to 30 KHz Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 Hz to 500 KHz
Flat within ±1 db	5 Hz to 800 KHz
Flat within ±2 db	5 Hz to 2 MHz
Modulation Linearity, Deviation from B.S.L.,	
For ±300 KHz peak Deviation	±0.5%
For ±1.5 MHz peak Deviation	±2.5%
Incidental Frequency Modulation, Maximum	5 KHz rms
AM, Maximum, due to environmental conditions	1%
due to ±300 KHz carrier deviation	1%
due to ±1.5 MHz carrier deviation	5%
Modulation Input Impedance, Minimum, 5 Hz to 800 KHz	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	5.5 Amperes
Primary Ripple, maximum, peak-to-peak from DC to 20 KHz	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
VSWR Maximum, any constant phase, for full output	1.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	500 hours

PACKAGING

Volume displaced	110 cubic inches
Dimensions	See Drawings, page 6
Weight	7.8 pounds
Pressurization	30 psia
Cooling	Conduction to heat sink

ENVIRONMENTAL SPECIFICATIONS[3]

Temperature[4] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration (MIL-STD-810, Figure 514-3, Curve D)	15G peak to 2 KHz
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/Hz
Air Induced Vibration	150 db above 2×10^{-4} dynes/CM^2 from 150 to 2000 Hz, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration	30G for 5 minutes, three axes
Shock, per MIL-STD-810 Method 516, Procedures I and V,	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[5]	100G

[6] ±0.001% available on special order.

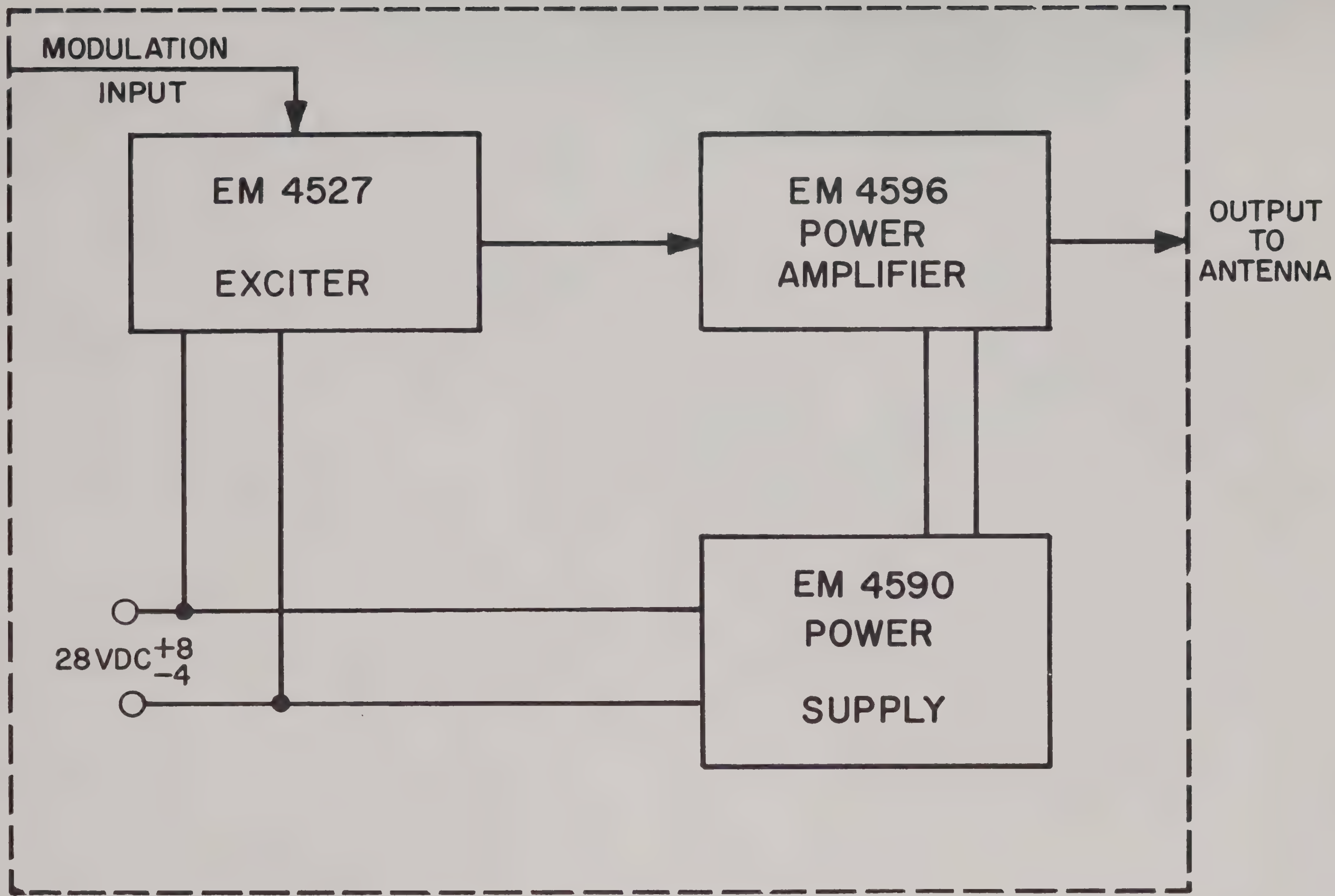
[5] Out-of-tolerance operation may occur during 100G shock.

[4] Other ranges available on special order.

[3] Transmitter performs as specified, under any combination of environmental conditions.

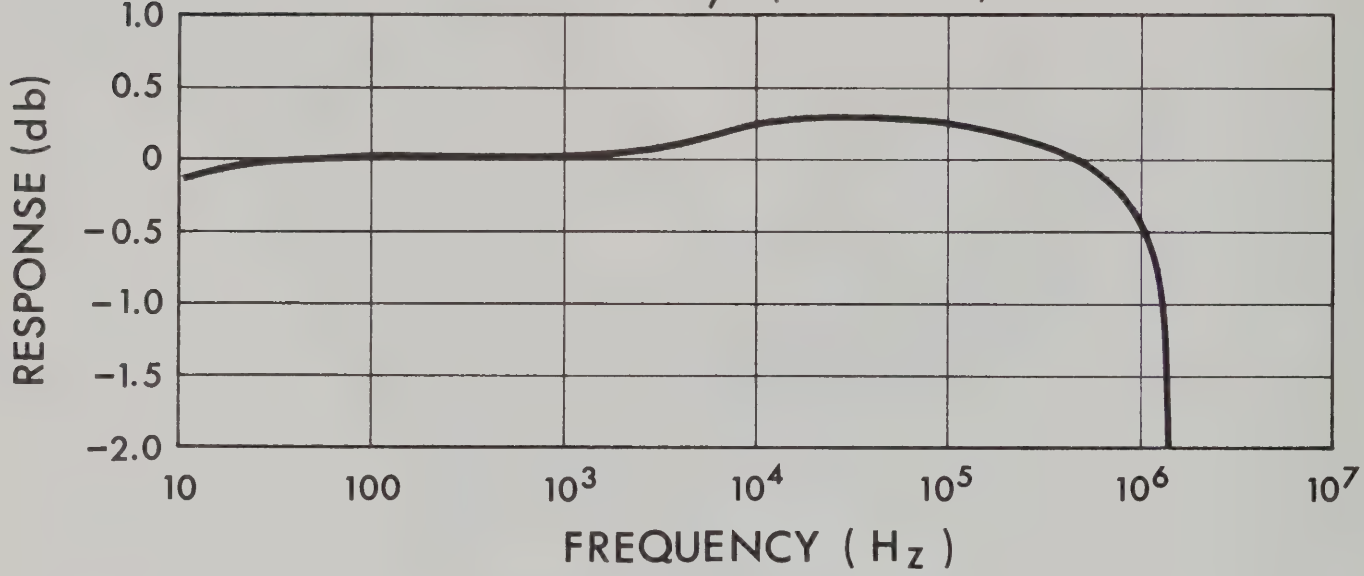
[2] Under emergency conditions, full rf output is provided with primary power as low as 20 Vdc, but increased IFM and AM will occur.

[1] Also available modified for modulation down to DC.

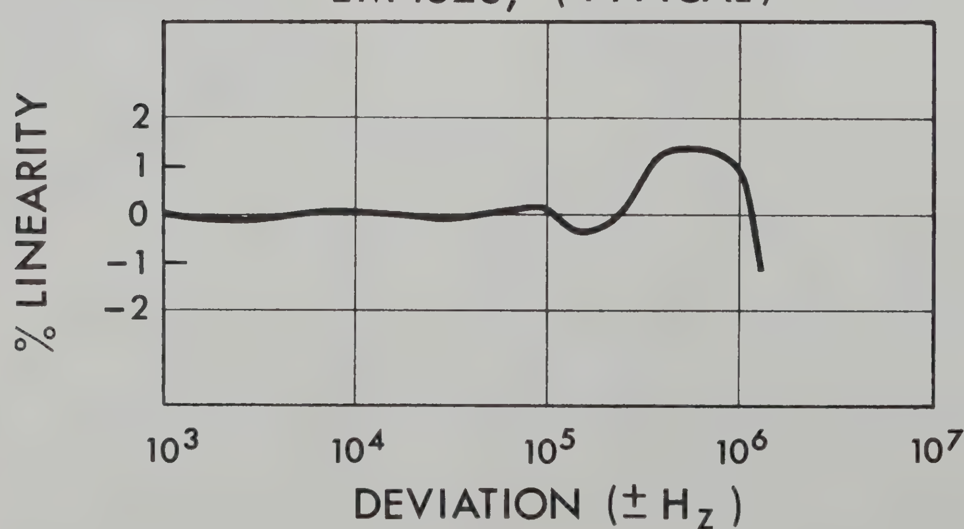


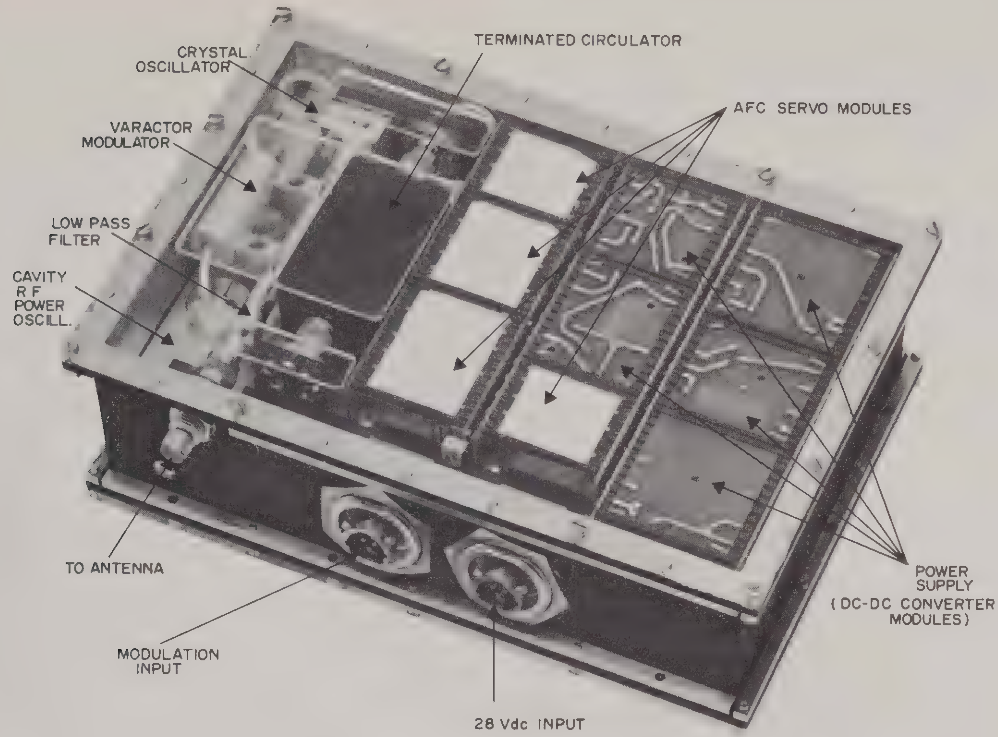
BLOCK DIAGRAM
4528 20 WATT S-BAND
TELEMETRY TRANSMITTER

MODULATION FREQUENCY RESPONSE OF TRANSMITTER EM4528, (TYPICAL)



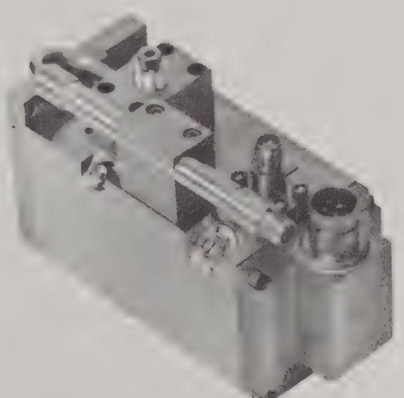
DEVIATION LINEARITY OF TRANSMITTER EM4528, (TYPICAL)





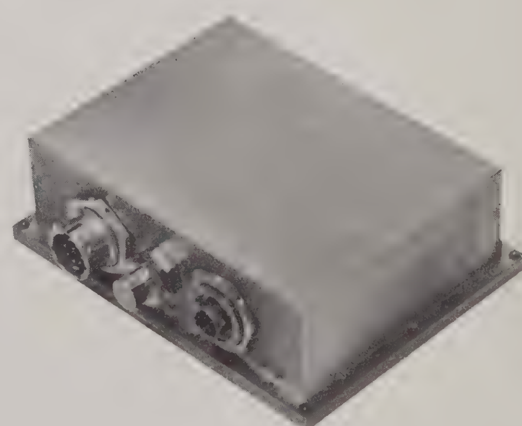
EM4527 EXCITER ASSEMBLY

EM4527 is a complete 2 watt transmitter, including a dc-dc converter. RF power is generated in a stable triode cavity oscillator. Frequency is stabilized by a crystal-referenced AFC servo loop. Power output and frequency remain stable under worst combinations of extremes of environment and primary power. Displaced volume is 50 cubic inches; weight is 4.3 lbs.



EM4596 RF POWER AMPLIFIER

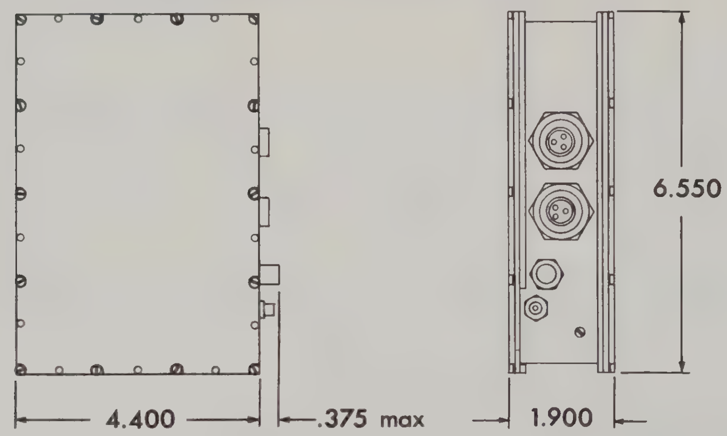
The EM4596 is a miniaturized 20 W cavity amplifier using a frequency-stable ceramic planar triode. It is hermetically sealed, for operation at any altitude. All connectors and tuners are accessible on one surface. A low pass filter, for harmonic suppression, is included. By mounting this amplifier close to the transmitting antenna, rf transmission line loss can be significantly reduced. This amplifier can operate continuously at heat sink temperatures of —54°C to +95°C, and for short periods without damage at higher temperatures. Weight is 0.95 lbs; volume is less than 14 cubic inches.



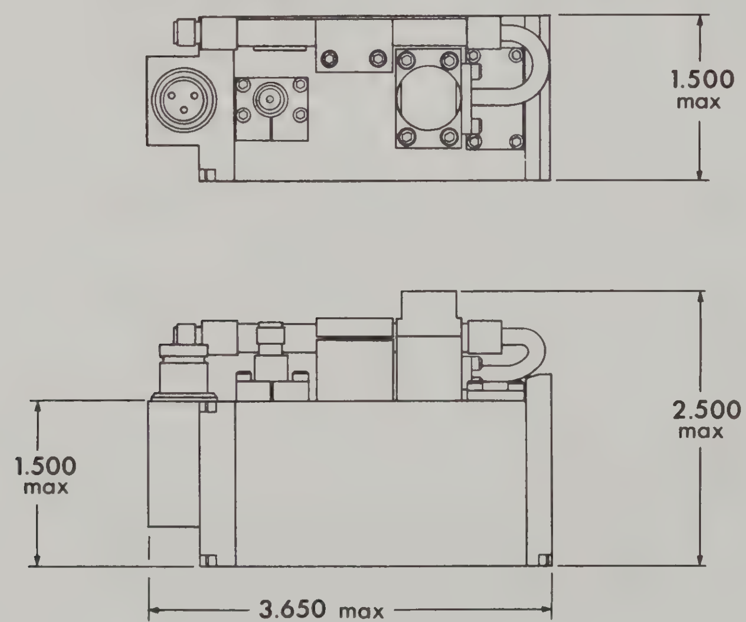
EM4590 POWER SUPPLY

EM4590 is a solid state dc-dc converter, miniaturized, conduction cooled, hermetically sealed. It meets operating specifications over a primary voltage range of 24-36 volts and heat sink temperature range of —54°C to +95°C. Volume is less than 39 cubic inches, weight 2.5 lbs.

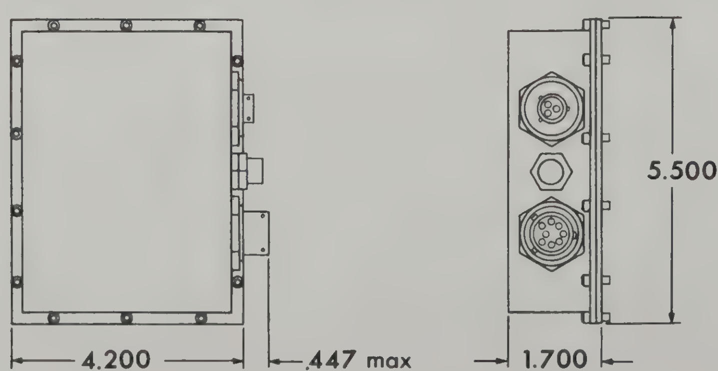
EM 4527 - EXCITER



EM 4596 - AMPLIFIER



EM 4590 - POWER SUPPLY



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EM4534

TELEMETRY TRANSMITTER

1435 - 1540 MHz
3 Watts

This EIMAC L-Band transmitter provides over 3 watts rf output with over 13% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. It is designed to operate during the severe shock and vibration of missile launch.

Model EM4534 is a complete transmitter, including a pre-regulated DC-DC converter. All circuits are solid state, except the rf power oscillator, which is a single stage rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter package displaces less than 50 cubic inches, and weighs 4.5 pounds. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 1435-1540 MHz band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range –40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 MHz is accomplished at ±2.5% linearity, and ±300 KHz at ±0.5% linearity.

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	1435-1540 MHz
Power Output, CW Minimum	3 Watts
Frequency Accuracy	$\pm 0.001\%$
Frequency Stability[7]	$\pm 0.0025\%$
Carrier Deviation, Adjustable, peak-to-peak	2MHz/Volt to 30KHz/Volt
Modulation Bandwidth,[1] Flat within ± 0.5 db	100 Hz to 500 KHz
Flat within ± 1 db	5 Hz to 800 KHz
Modulation Linearity, Deviation from B.S.L.,	
For ± 300 KHz peak Deviation	$\pm 0.5\%$
For ± 1.5 MHz peak Deviation	$\pm 2.5\%$
Incidental Frequency Modulation, Maximum	5 KHz rms deviation
AM, Maximum, due to environmental conditions	1%
due to ± 300 KHz carrier deviation	1%
due to ± 1.5 MHz carrier deviation	5%
Modulation Input Impedance, Minimum, 5 Hz to 800 KHz	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	825 mA
Primary Ripple, maximum, peak-to-peak from DC to 20 KHz	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
Input current rise above nominal, due to fault,[3] maximum	130%
VSWR Maximum, any phase, for 3 watts output	1.5:1
for 1.5 watts output	5.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	500 hours

PACKAGING

Volume displaced	48 cubic inches
Dimensions, including mounting flanges	6.5″ x 4.4″ x 1.9″
Weight	4.5 pounds
Pressurization	30 psia
Cooling	Conduction through bottom plate to heat sink

ENVIRONMENTAL SPECIFICATIONS[4]

Temperature[5] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration (MIL-STD-810, Figure 514-3, Curve D)	15G peak to 2 KHz
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/Hz
Air Induced Vibration	150 db above $2x10^{-4}$/dynes/CM^2 from 150 to 2000 Hz, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration	30G for 5 minutes, three axes
Shock, per MIL-STD-810 Method 516, Procedures I and V	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[6]	100G

[7] $\pm 0.001\%$ available on special order.

[6] Out-of-tolerance operation may occur during 100G shock.

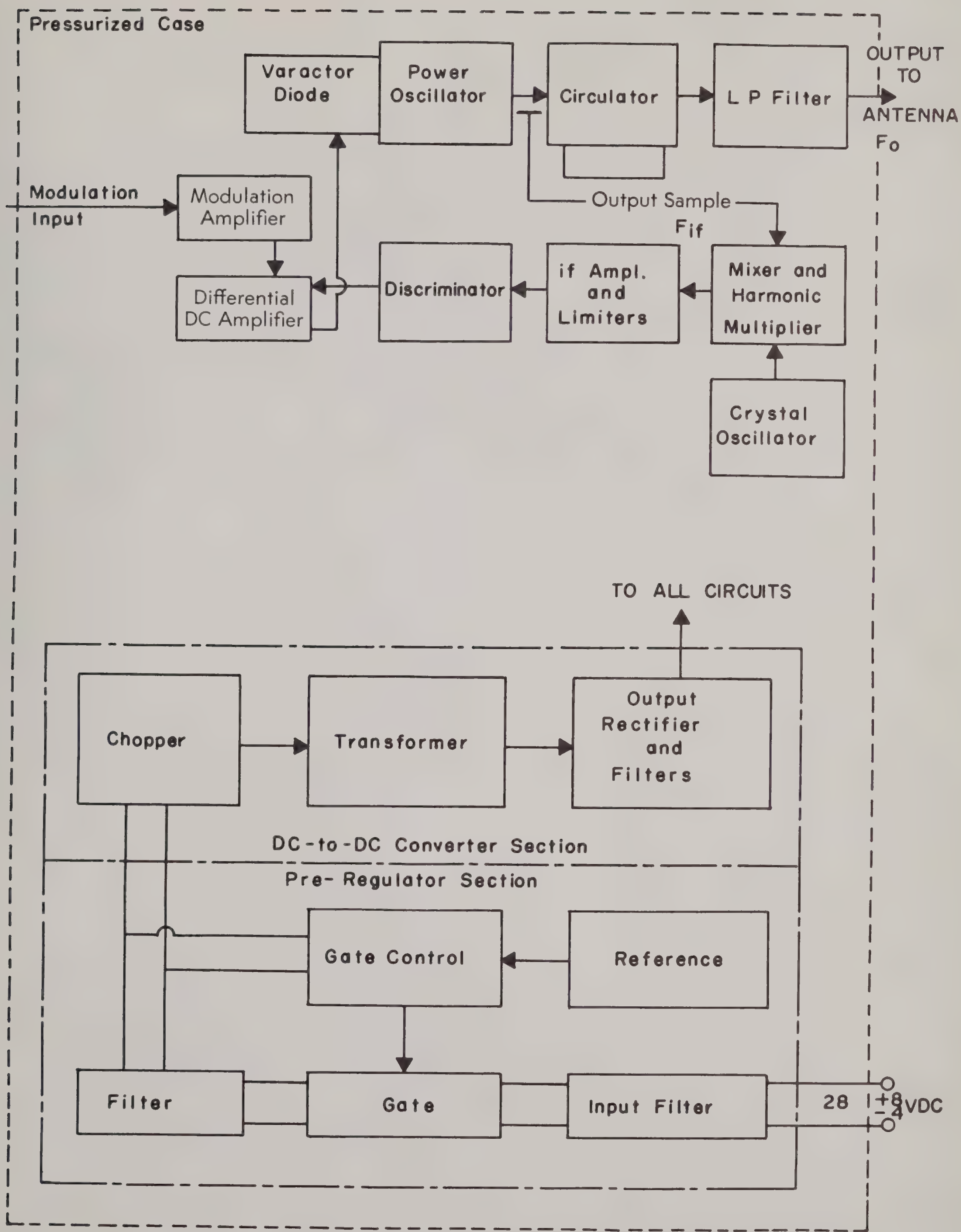
[5] Other ranges available on special order.

[4] Transmitter performs as specified, under any combination of environmental conditions.

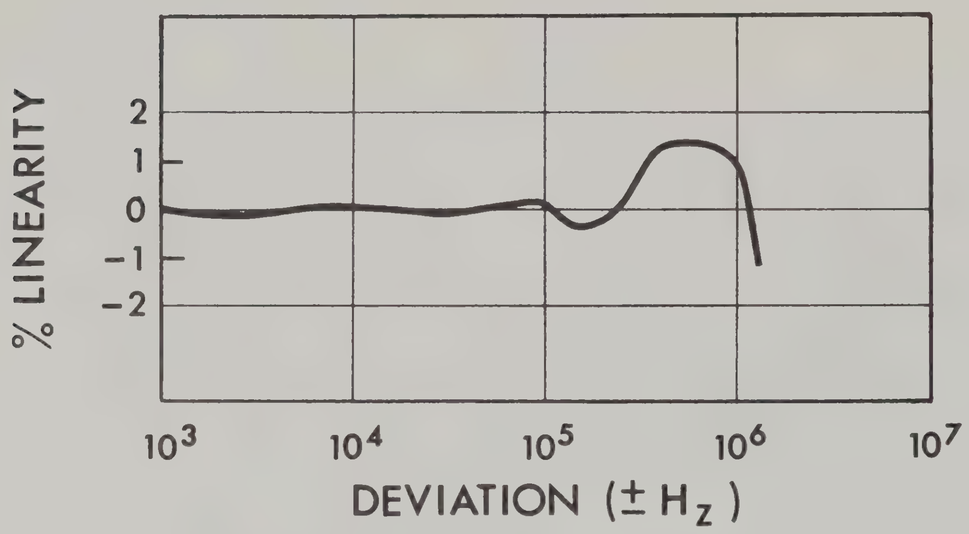
[3] Any failure of transmitter (except at input terminals.)

[2] Under emergency conditions, full rf output is provided with primary power as low as 22 Vdc, but increased IFM and AM will occur.

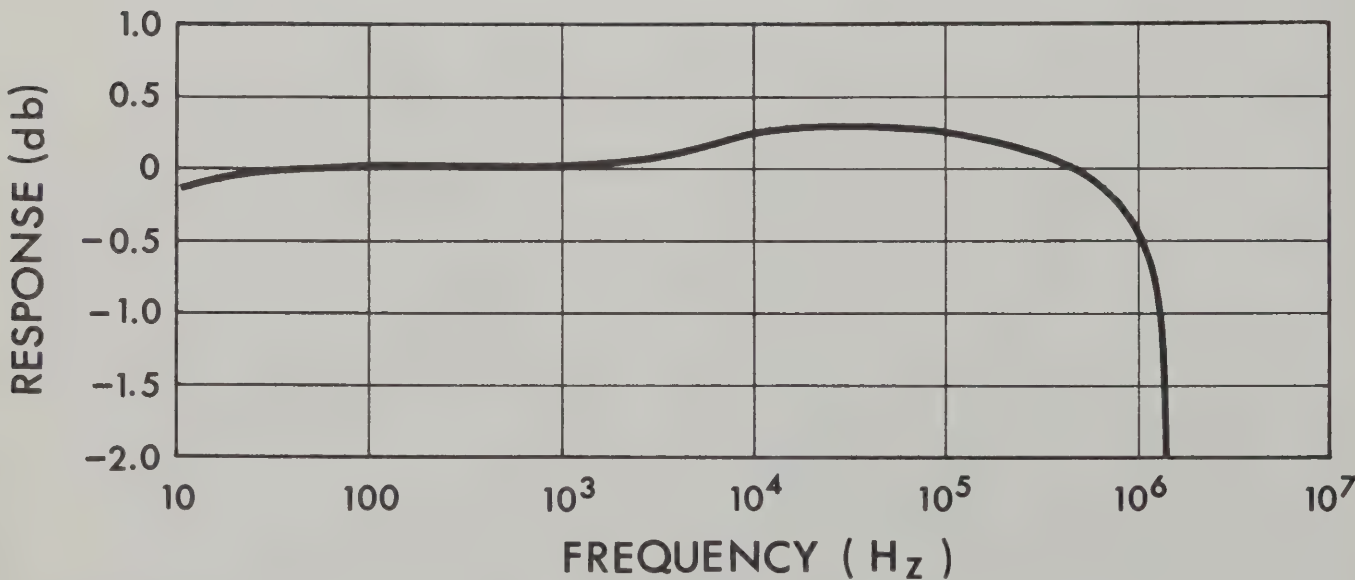
[1] Also available modified for modulation down to DC; and up to 2 MHz



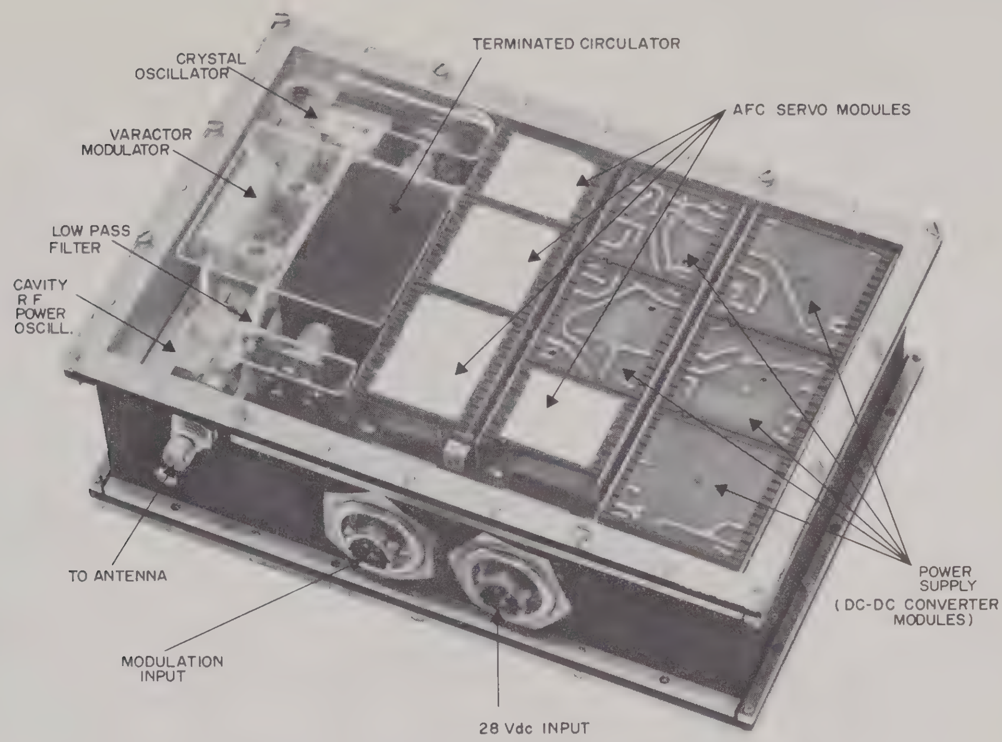
BLOCK DIAGRAM
MODEL EM4534 3W S-BAND TELEMETRY TRANSMITTER



TYPICAL DEVIATION LINEARITY OF TRANSMITTER

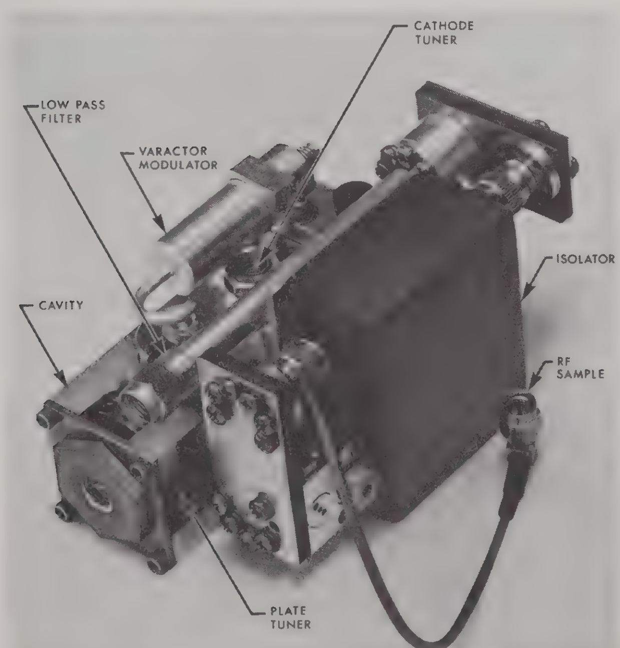


TYPICAL MODULATION FREQUENCY RESPONSE OF TRANSMITTER



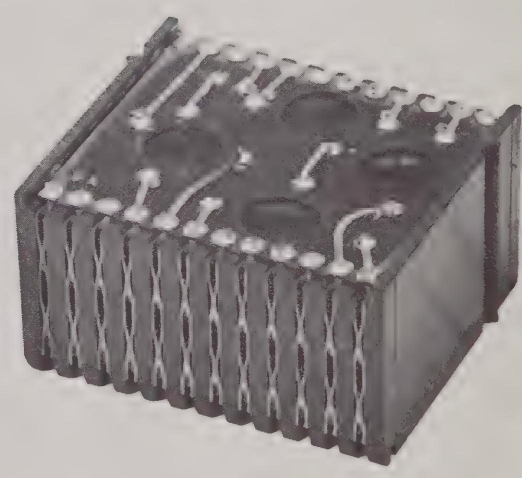
EM4534 TELEMETRY TRANSMITTER ASSEMBLY

Packaging of this transmitter is compact, yet all modules are easily accessible by removing top and bottom covers. The covers incorporate pressure seals and rfi gaskets.



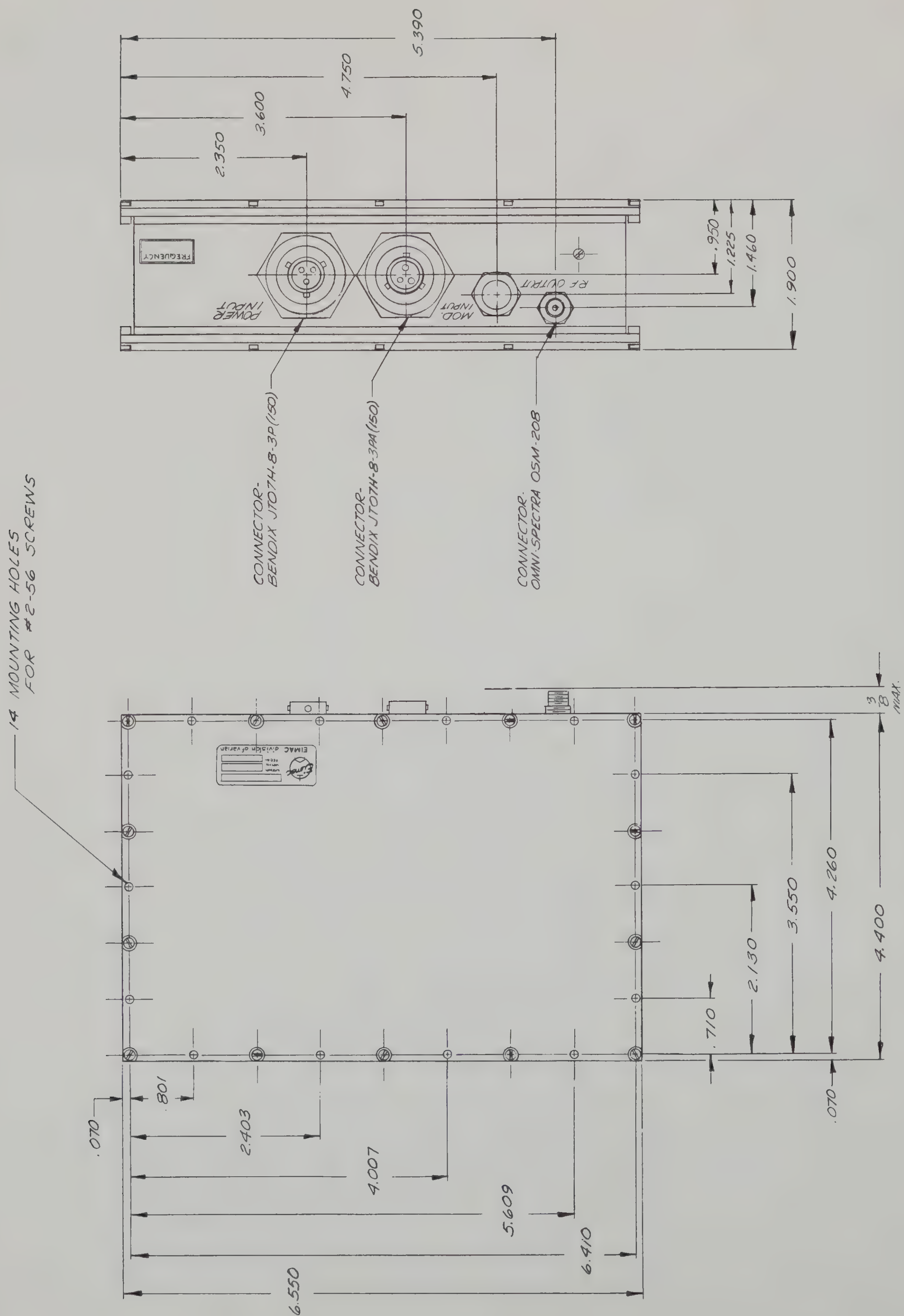
RF SECTION, EM4534 TRANSMITTER

The rf power oscillator provides over 3 watts, tunable 1435-1540 MHz. There is no output below 1435 MHz. Harmonics are removed by a low pass filter. The ceramic planar triode in the oscillator is conduction cooled to the transmitter case.



TYPICAL PLUG-IN MODULE

Circuits use only high reliability components such as silicon planar transistors and are packaged in modular form. The modules are easily removable, and offer flexibility for future modification. The connector system provides four redundant contacts at each connection. Modules are encapsulated with a rigid high thermal conductivity compound for heat conduction and vibration protection.

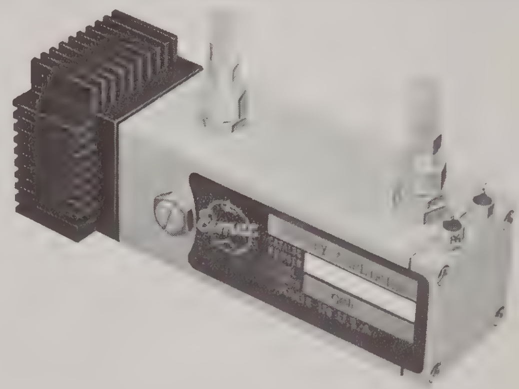

5.390
4.750
3.600
2.350
FREQUENCY
POWER INPUT
MOD. INPUT
RF OUTPUT
.950
1.225
1.460
1.900
CONNECTOR-BENDIX JT07H-8-3P(150)
CONNECTOR-BENDIX JT07H-8-3PA(150)
CONNECTOR-OMNI SPECTRA OSM-208
14 MOUNTING HOLES FOR #2-56 SCREWS
EIMAC division of varian
3/8 MAX.
4.400
4.260
3.550
2.130
.710
.070
.801
2.403
4.007
5.609
6.410
6.550
.070

EIMAC
A Division of Varian Associates

Tentative Data

X4576
CAVITY AMPLIFIER

2300-2600* MHz
20 Watts CW



The X4576 cavity amplifier is recommended for use in airborne and ground transmitters. It is a compact, lightweight, high efficiency amplifier using a ceramic-metal planar triode. It will withstand the severe environmental conditions of missile and aircraft operation. Field tuning is simple.

A recommended dc-dc converter for use with this unit is EIMAC Model EM4590.

CHARACTERISTICS

ELECTRICAL

Frequency,* continuously tunable	2300-2450 MHz 2450-2600 MHz
rf Power Output (2 watts drive), at 2300 MHz	20 watts
2450 MHz	18 watts
2600 MHz	15 watts
Bandwidth, Minimum, 3 db points	5 MHz
Gain, Minimum, 2300 MHz	10 db
2600 MHz	8 db
Load Impedance, Nominal	50 Ohms
VSWR, Maximum, for full rated output (fixed phase)	1.5:1
without damage	3:1
Power Supply Requirements	
Anode Voltage, Maximum	800 Volts
Current, Maximum	125 mA
Heater Voltage	6.0 Volts
Current	1.0 Amperes
Warm-up Time	3 minutes

MECHANICAL

Size (excluding protrusions), maximum	1¼″ x 1¼″ x 4⅜″
Weight	1.2 Pounds
Mounting	To heat sink (not included)
Tuning Controls	Four (two for coupling, two for frequency)
Cooling	Conduction to heat sink at —40°C to +85°C
Connectors	Type OSM, Female

ENVIRONMENTAL

Temperature, heat sink, for continuous operation	—40°C to +85°C
Altitude	0 to 20,000 feet
Vibration	10 g, 5-500 cps, 15 minutes in 3 mutually perpendicular planes
Shock	15g for 11 milliseconds in 3 mutually perpendicular planes

*Factory-adjusted for tuning range of 2.3-2.45 GHz or 2.45-2.6 GHz.

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

EIMAC
A Division of Varian Associates
ARLOS, CALIFORNIA

Tentative Data

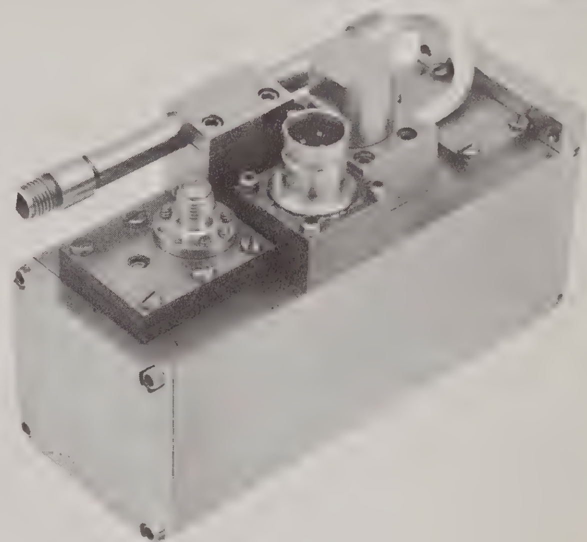
X4592

CAVITY AMPLIFIER

1700-1850 MHz
25 Watts CW

The X4592 cavity amplifier is recommended for use in aerospace telemetry, television and general-purpose transmitters. It may be used with transmitters having wide modulation bandwidth. Its small size and light weight are major advantages for aerospace use. This unit is hermetically sealed; it may be used at any altitude. It uses a ceramic-metal planar triode. Operation is satisfactory during the severe environmental conditions of missile launch.

A recommended dc-dc converter for use with this amplifier is EIMAC Model EM4590.



CHARACTERISTICS

ELECTRICAL

Frequency,[1] continuously tunable - - - - - - - - - - - 1700-1850 MHz

Rf power[2] output (with 2 watts drive) - - -

Frequency (MHz)	Power Output (Watts) CW
1700-1750	20
1750-1800	25
1800-1850	20

Input Signals - - - - - - All standard FM telemetry signal formats, per IRIG 106-65

Bandwidth, Minimum, 3 db points - - - - - - - - - - - - - 10 MHz

Gain, Minimum, 1700-1850 MHz - - - - - - - - - - - - - 10 db

Load Impedance, nominal - - - - - - - - - - - - - - - 50 ohms

VSWR, Maximum, for full rated output - - - - - - - - - - - - 1.5:1
without damage - - - - - - - - - - - - 3:1

Efficiency,[2] Overall, Minimum - - - - - - - - - - - - - - 25%

Phase jitter, Maximum, between input and output - - - - - - - - - 5° peak

Power Supply Requirements[3]:
- Anode voltage - - - - - - - - - - - - - - - 600 Volts
- Current - - - - - - - - - - - - - - - 125 mA
- Heater voltage - - - - - - - - - - - - - - - 5.5 Volts
- Current - - - - - - - - - - - - - - 1.2 Amperes

Warm-up Time - - - - - - - - - - - - - - - 3 Minutes

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

MECHANICAL

Size, Overall (including protrusions)	4″ x 2½″ x 1½″
Weight	1.1 pounds
Mounting	To Heat Sink (not included)
Tuning Controls	Three (all on same surface)
Cooling	Conduction to Heat Sink at —54°C to +95°C
Connectors: rf input	OSM Female
rf output	OSM Female
Power	Deutsch #DM 5300-3P-643

ENVIRONMENTAL

Temperature, heat sink, for continuous operation	—54°C to +95°C
Altitude	Any
Vibration	20g, 20-2000 cps, 3 major axes
Other	Per MIL-E-5400

FOOTNOTES:

(1) Also available with similar performance characteristics for other frequencies in the 900-2500 MHz range.

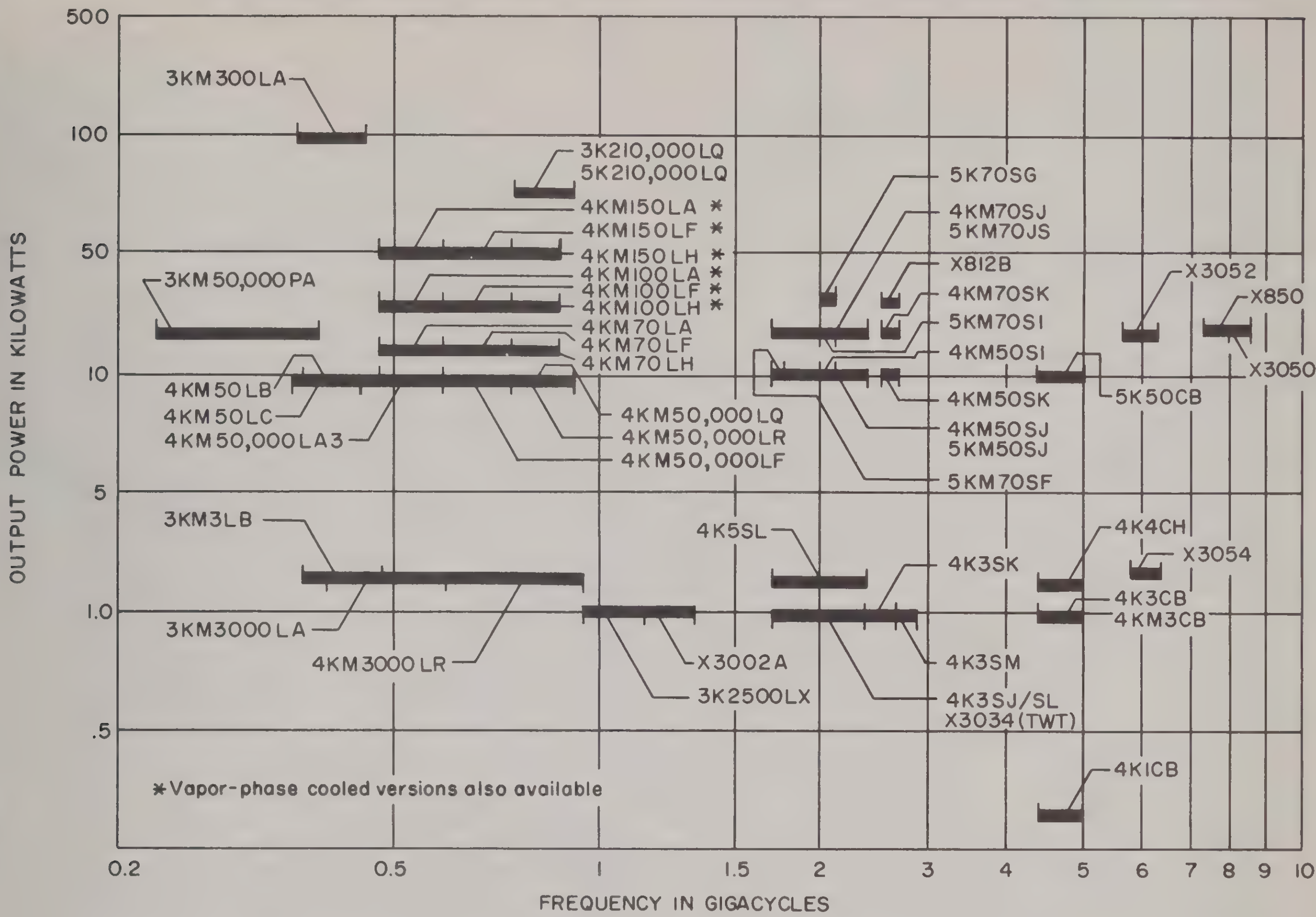
(2) Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions.

(3) A separate DC-DC converter package, Model EM4590, operating from 28 +8/—4 Vdc, is available from EIMAC. Power supplies for operation from other primary sources are available on special order.

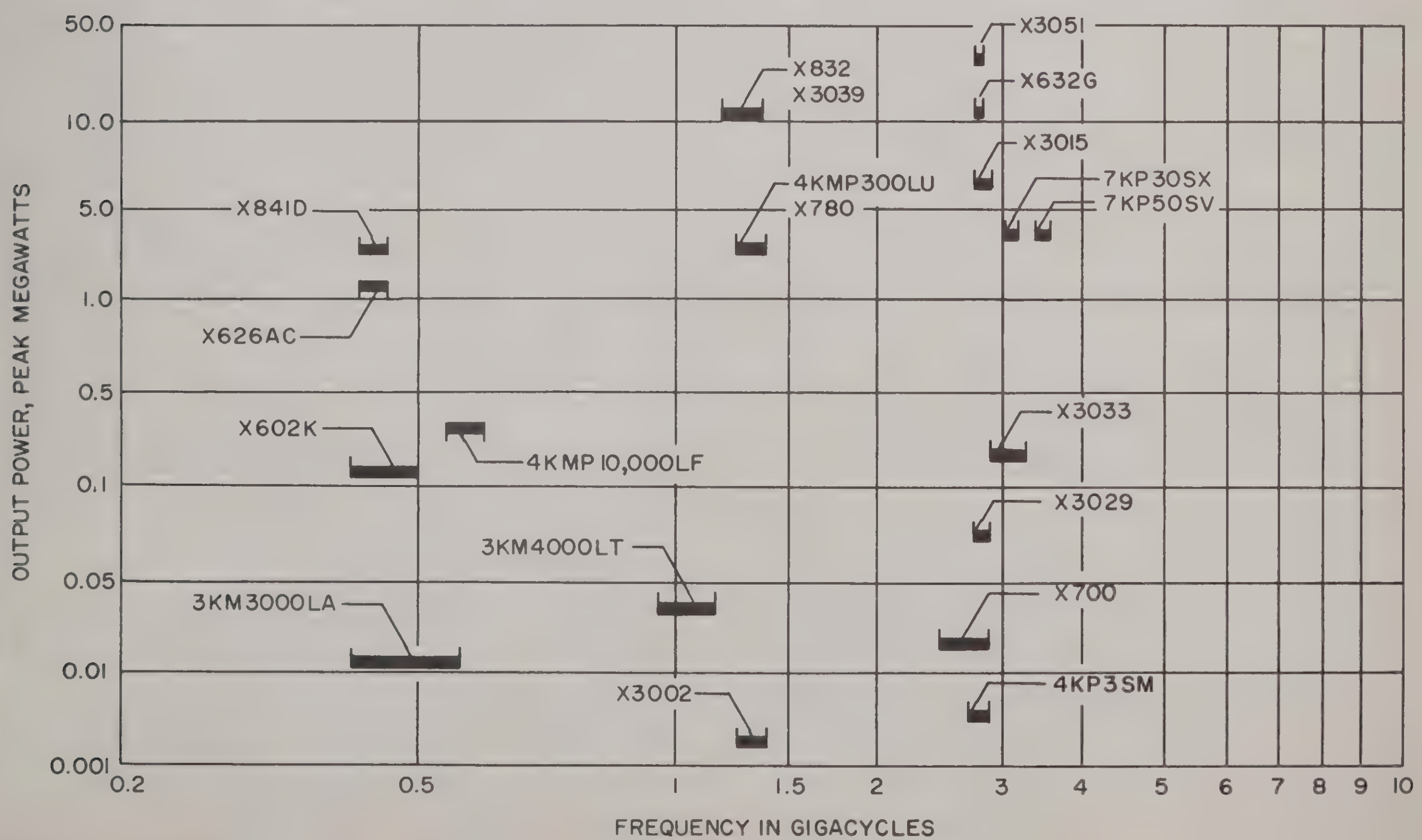
TABLE OF CONTENTS
VOL. II

EIMAC HIGH POWER MICROWAVE TUBES

CW MICROWAVE TUBES RECOMMENDED FOR NEW EQUIPMENT DESIGN

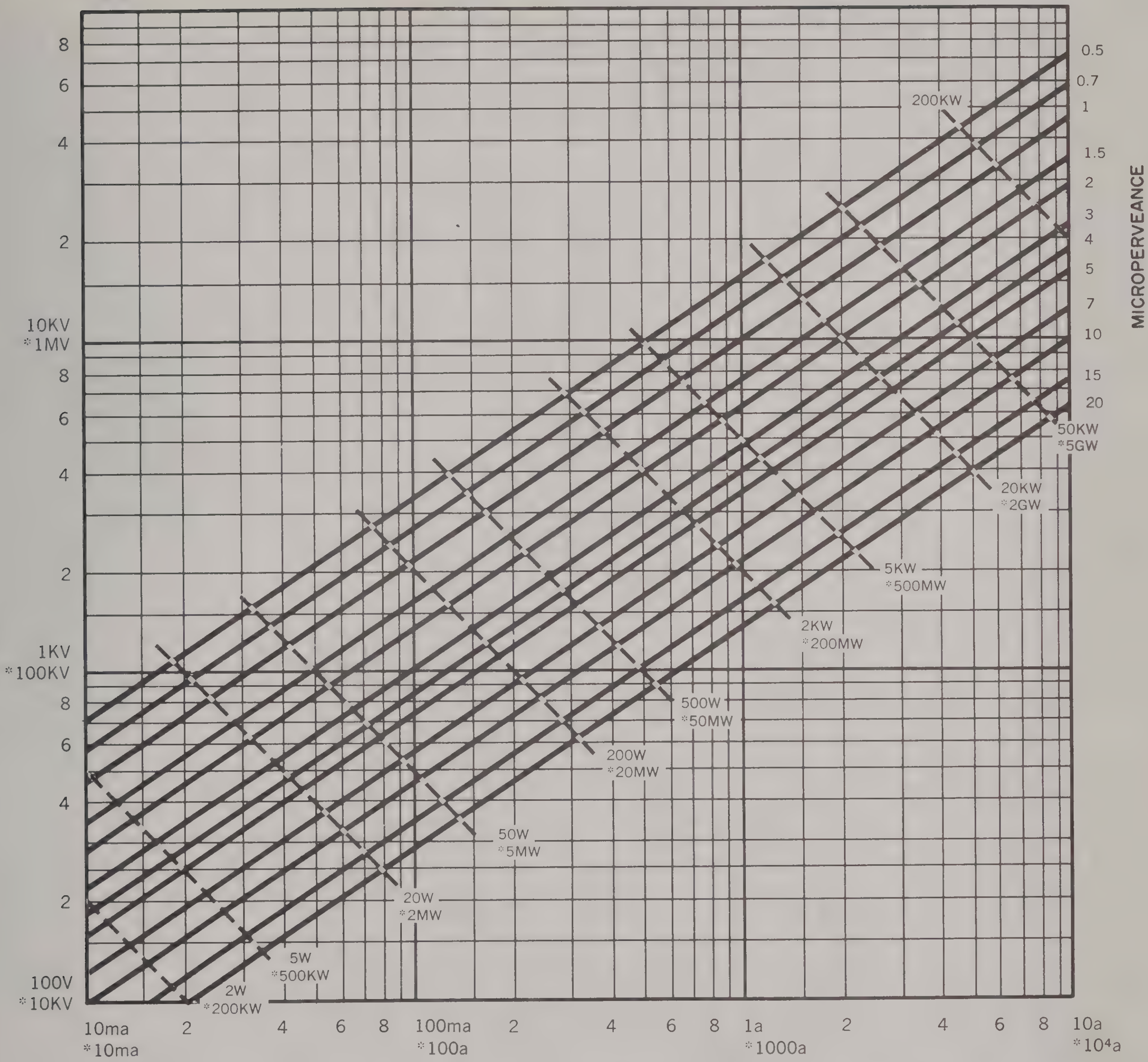


PULSE MICROWAVE TUBES RECOMMENDED FOR NEW EQUIPMENT DESIGN



EIMAC BEAM CALCULATOR

11/20/64



- - - - - - CONSTANT POWER LINES
———— CONSTANT PERVEANCE LINES

* NUMBERS PERTAINING TO HIGHER SCALE

EITEL-McCULLOUGH, INC.

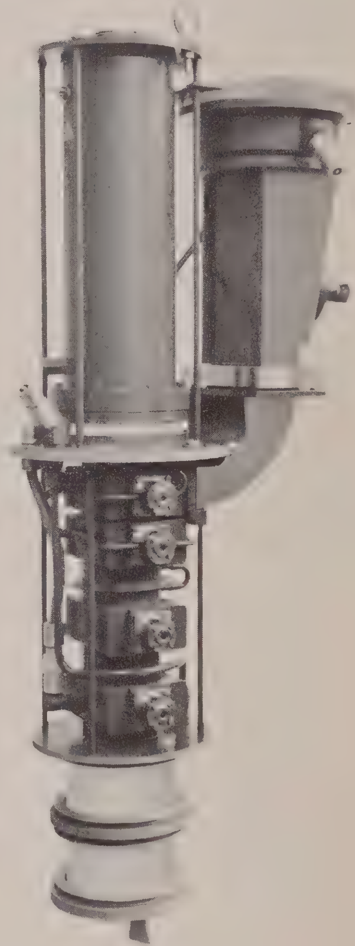
4KM50SJ

POWER AMPLIFIER KLYSTRON

12 kW
1.7 - 2.4 Gc

The 4KM50SJ is a four-cavity, power amplifier klystron intended primarily for use in tropospheric scatter communications systems. When tuned for maximum efficiency, it produces a minimum output power of 12 kilowatts, at frequencies from 1.7 to 2.4 gigacycles, with a minimum gain of 40 decibels.

The electron gun of this klystron has a confined flow configuration which minimizes focusing adjustments and produces a stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting rf output or body current. Only one electromagnet power supply is required. Cathode current loading is less than 200 milliamperes per square centimeter. This light cathode loading contributes to long life.



Both input and output couplings of the 4KM50SJ are fixed. The only adjustments required are therefore the tuning of the four integral cavities. The output window is a thick beryllium oxide disc which is protected by a photo-cell arc detector.

The 4KM50SJ incorporates a built-in vacuum pump in the form of a titanium getter which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the Eimac Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-158, has been designed for use with the 4KM50SJ.

Eimac Water Load WL-202 is recommended for use with the 4KM50SJ.

CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential	
Heating time	5 minutes
Heater: Voltage (±5%)	7.5 volts
Current	12 amperes
Getter: Voltage	4 volts ac
Amperes	24 amperes ac
Power Gain	40 decibels
Output Power	12 kilowatts
Frequency Range	1.7-2.4 gigacycles
Phase sensitivity to beam voltage	0.058 degrees/volt

MECHANICAL

Maximum Dimensions (4KM50SJ and H-158 Electromagnet)	
Length	33 inches
Diameter	18 inches
Weight (4KM50SJ)	90 pounds
Weight (H-158 Electromagnet)	170 pounds
Input Coupling (rf)	Type N Coaxial
Output Coupling (rf)	UG435A/U Flange
Maximum Tuner Start Torque	70 in-oz
Maximum Tuner Stop Torque	30 in-lbs
Mounting Position Preferred	vertical, cathode down

Cooling: Water and Forced Air

	Flow Rate	*Pressure Drop*
Cathode	20 cfm	free
Body	1.2 gpm	50 psi
Collector	18 gpm	30 psi
Electromagnet	1.5 gpm	15 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage	150 volts
Current	15 amperes

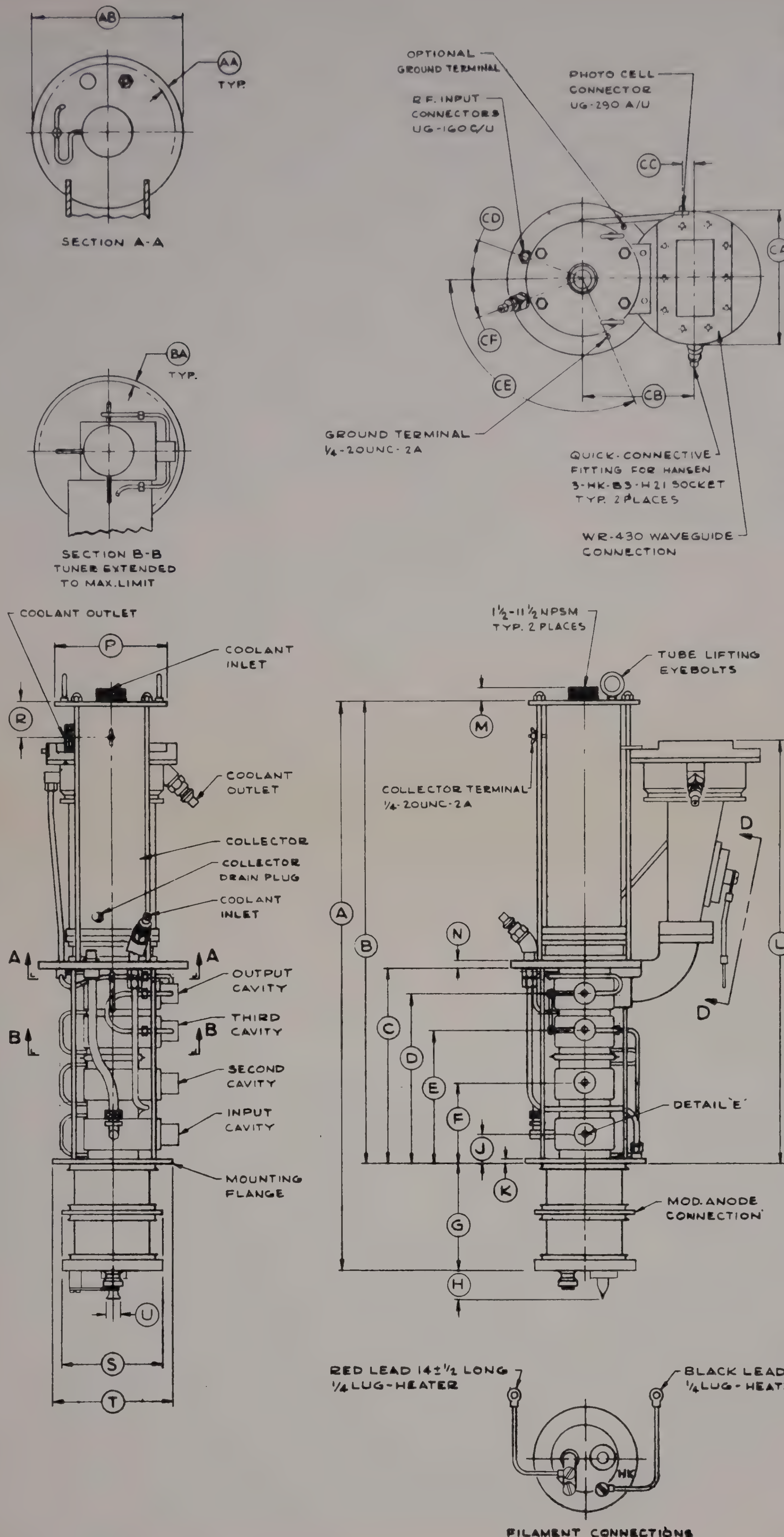
MAXIMUM RATINGS

BEAM VOLTAGE (dc)	20 KILOVOLTS
BEAM CURRENT (dc)	3 AMPERES
BEAM INPUT POWER	50 KILOWATTS
BODY CURRENT (dc)	75 MILLIAMPERES
COLLECTOR DISSIPATION	50 KILOWATTS
LOAD VSWR	1.5:1
INLET WATER PRESSURE	80 PSIG
OUTLET WATER TEMPERATURE	80 DEGREES C

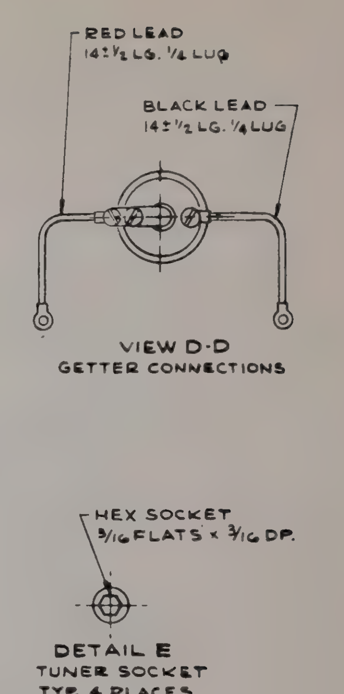
TYPICAL OPERATION

	High Eff. Tuned		*Broadband Tuned*		
Frequency	1.7	2.4	1.7	2.4	gigacycles
Output Power	14.5	12.3	12.1	10.5	kilowatts
Driving Power	1	1	1	1	watt
Gain	41.6	40.9	40.8	40.2	decibels
Beam Voltage	18	18	18	18	kilovolts dc
Beam Current	1.8	1.8	1.8	1.8	amperes dc
Modulating Anode Voltage (to cathode)	10.4	10.4	10.4	10.4	kilovolts dc
Beam Power Efficiency	44.5	38.0	37.2	32.4	percent
Half Power Bandwidth	5	8	10	12	megacycles
Body Current	65	50	55	35	milliamperes dc
Electromagnet Current	12.5	12.5	12.5	12.5	amperes

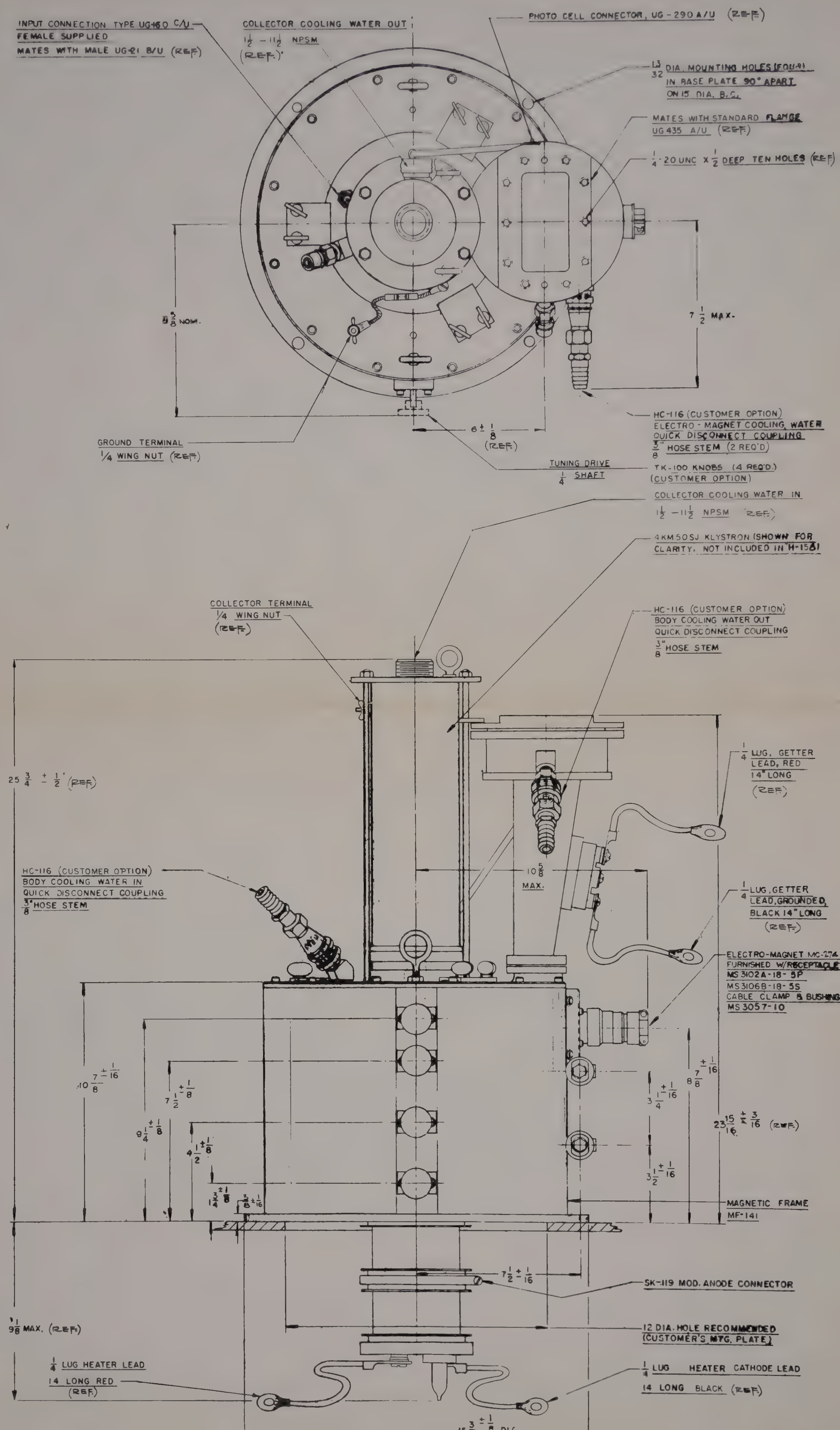
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.



DIMENSIONAL DATA			
REF	NOM.	MIN.	MAX.
A	30.366		
B	24.670		
C		10.325	10.525
D	9.125		
E	7.375		
F	4.388		
G	5.696		
H	2.188		
J	1.638		
K		.230	.270
L		23.600	24.000
M			1.000
N		.345	.405
P		5.950	6.050
R		1.470	1.720
S			5.280
T		6.490	6.500
U			1.188
AA		.437	
AB		7.990	8.000
BA		.380	
CA		6.970	7.030
CB		5.750	6.250
CC		510	.610
CD		15°	25°
CE		110°	120°
CF		15'	25°



4KM50SJ KLYSTRON



H-158 ELECTROMAGNET AND KLYSTRON SUPPORTING STRUCTURE

EITEL-McCULLOUGH, INC.

X-1153-C

LOW NOISE VOLTAGE TUNABLE MAGNETRON

Frequency 0.6 - 1.2 Gc

Minimum Output Power 20 mW

TYPICAL PERFORMANCE

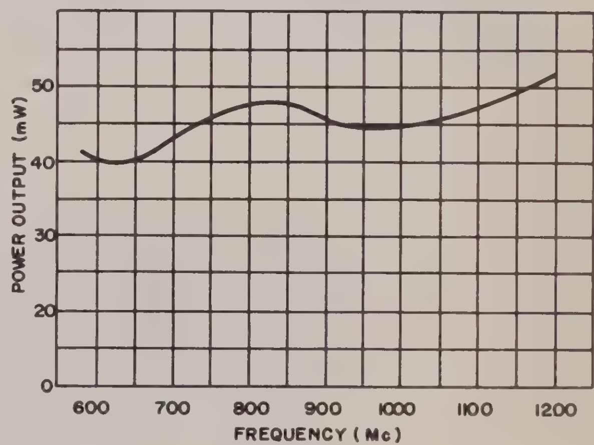
ELECTRICAL

Frequency Range	0.6-1.2 Gc
Anode Voltage	1000-2000 V
Cathode Current	2-4 mA
Typical Output Power	30-50 mW
Anode FM Sensitivity	.66 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.02 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
Noise	—85 db (See Note 5)
VSWR (max)	2:1

*MAXIMUM RATINGS

Anode Voltage	2300 V
Cathode	10 mA
Injection Anode Voltage	+300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

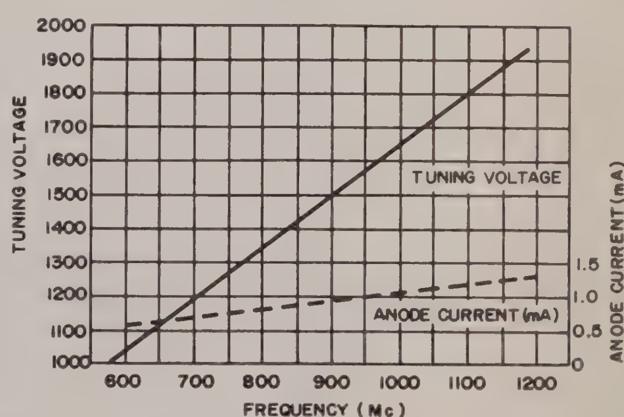


MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type TNC Jack (See Outline Drawing)
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10G-(to 2 kc)
Shock	100G-(11 ms)
Altitude	70,000 ft.



OUTLINE DIMENSIONS

Height	3.1 inches
Width	2.5 inches
Length	4.6 inches

(Effective 10-16-64)

APPLICATION NOTES

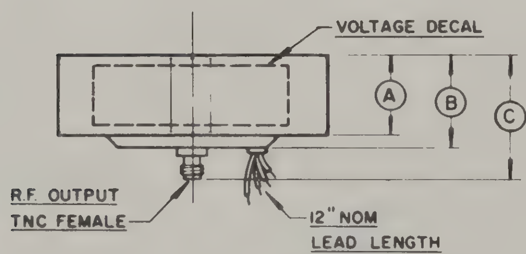
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1153-C has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. This temperature/frequency coefficient for the X-1153-C package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 700 megacycles, the temperature/frequency coefficient is typically 56 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

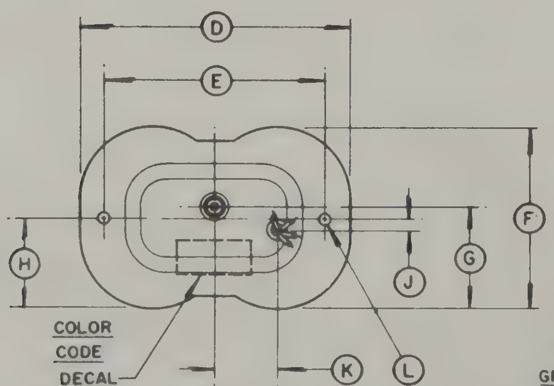
4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. NOISE: Noise power, in db below carrier, is measured using a 60 Mc I_f which has a bandpass of 2 Mc. Both sidebands are included in the measurement. (This measuring technique is one of many methods available. Other methods will be entertained.)



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF	MIN.	MAX.	NOM
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.



CONNECTIONS

GROUND – GREEN

HEATER – WHITE

HEATER CATHODE – BLACK

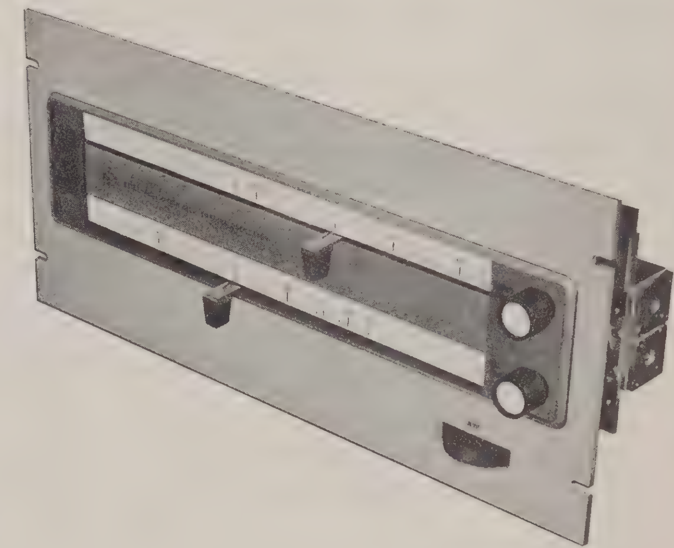
INJECTION ANODE – YELLOW

Eimac

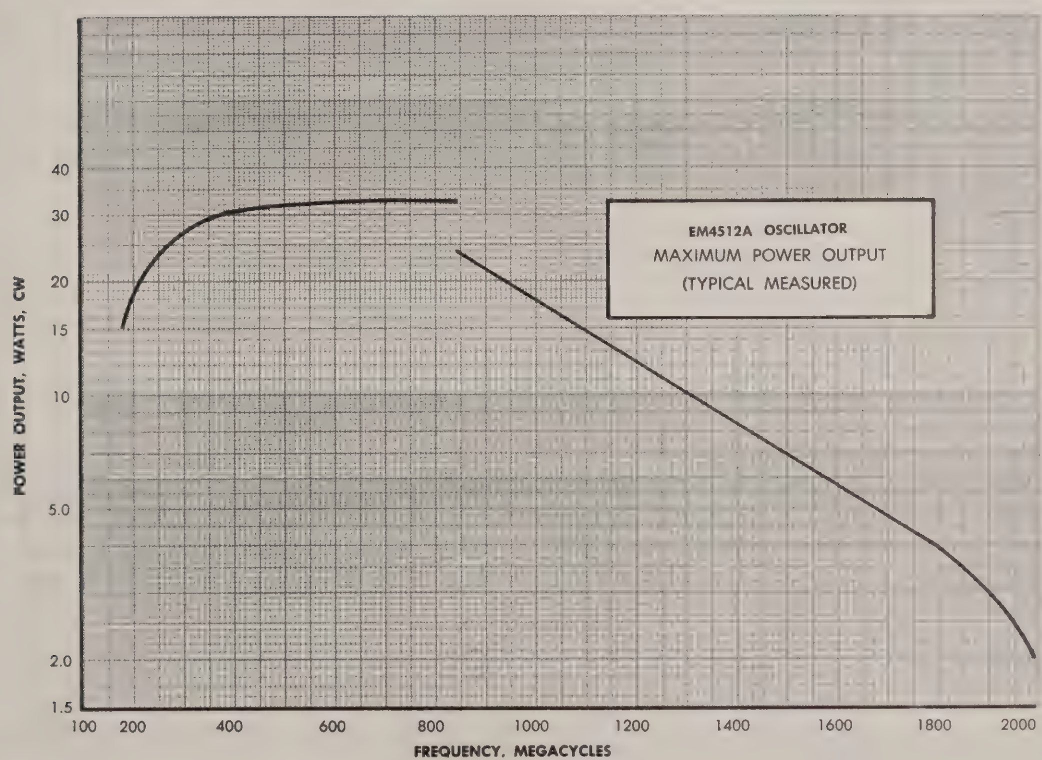
EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

EM4512A

BROAD TUNING OSCILLATOR 170-2000 Mc



The Eimac EM4512A is a broad-tuning cavity power oscillator incorporating the Eimac Y-319 ceramic-metal planar triode. It is intended for use in test equipment consoles and special transmitters. This oscillator has front-panel tuning knobs and frequency scales for tuning across the 170-2000 Mc band with power output from 25 to 2 watts.



CHARACTERISTICS

ELECTRICAL

Frequency, continuously tunable		170-2000 Mc
RF Power Output, minimum	Frequency, Mc	Power output, watts, CW
	170- 300	15
	300- 800	25
	800-1200	10
	1200-1600	5
	1600-2000	2
Frequency Drift,[1] percent of operating frequency		±0.05%
Power Supply Requirements:	Voltage	Current
Anode, maximum	1 KV	100 mA
Grid	Bias through variable cathode resistor, 200-1000 ohms	
Heater	6.0 V	1 A
Ground	Positive terminal of anode supply	
Cathode Current		125 mA
Tube Type		Eimac Y-319
Load Impedance		50 ohms nominal
Load VSWR, maximum		2.0:1 any phase, without damage

MECHANICAL

Mounting	Standard 19" relay rack
Size	height — 8¾ inches depth — 4½ inches
Weight	10 pounds
Operating Controls	Tuning knobs and frequency scales provided[2]
Cooling	Conduction — Convection[3]
Connector	Type TNC Female

ENVIRONMENTAL

Temperature	—10 to +50°C (+14 to +122°F)[3]
Altitude	to 12,000 feet

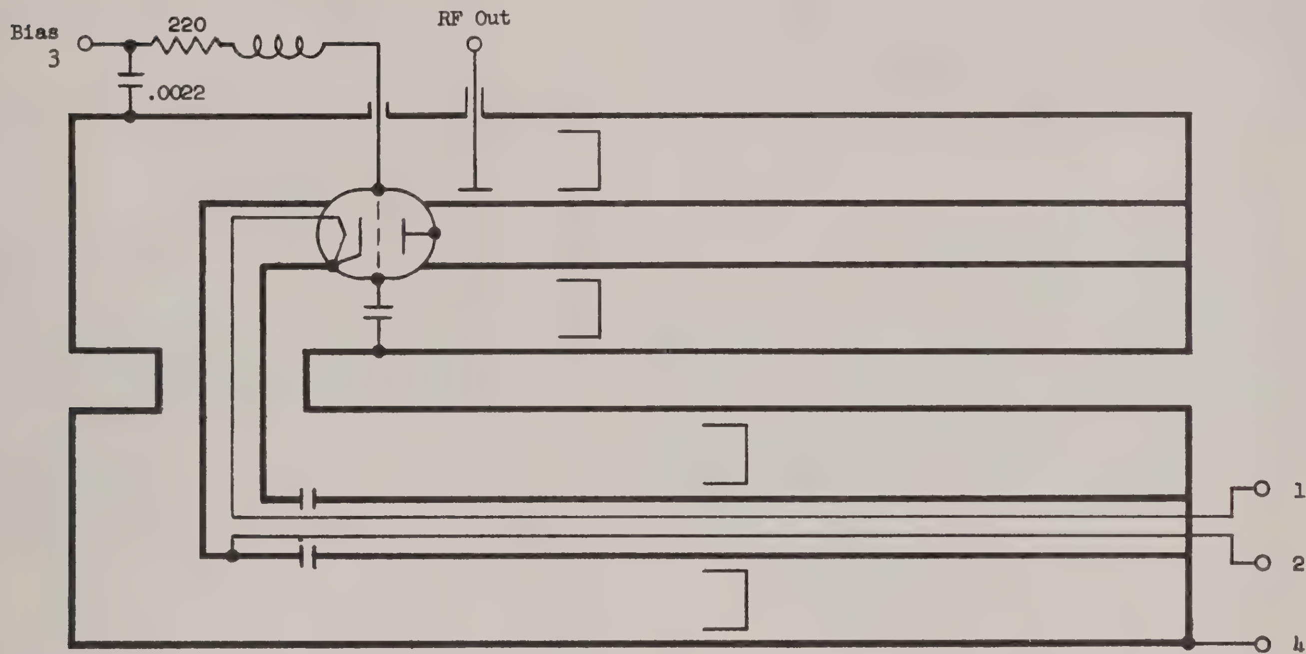
NOTES:

(1) Frequency drift is specified over a period of 2 hours, following a warm-up period of ½ hour minimum.

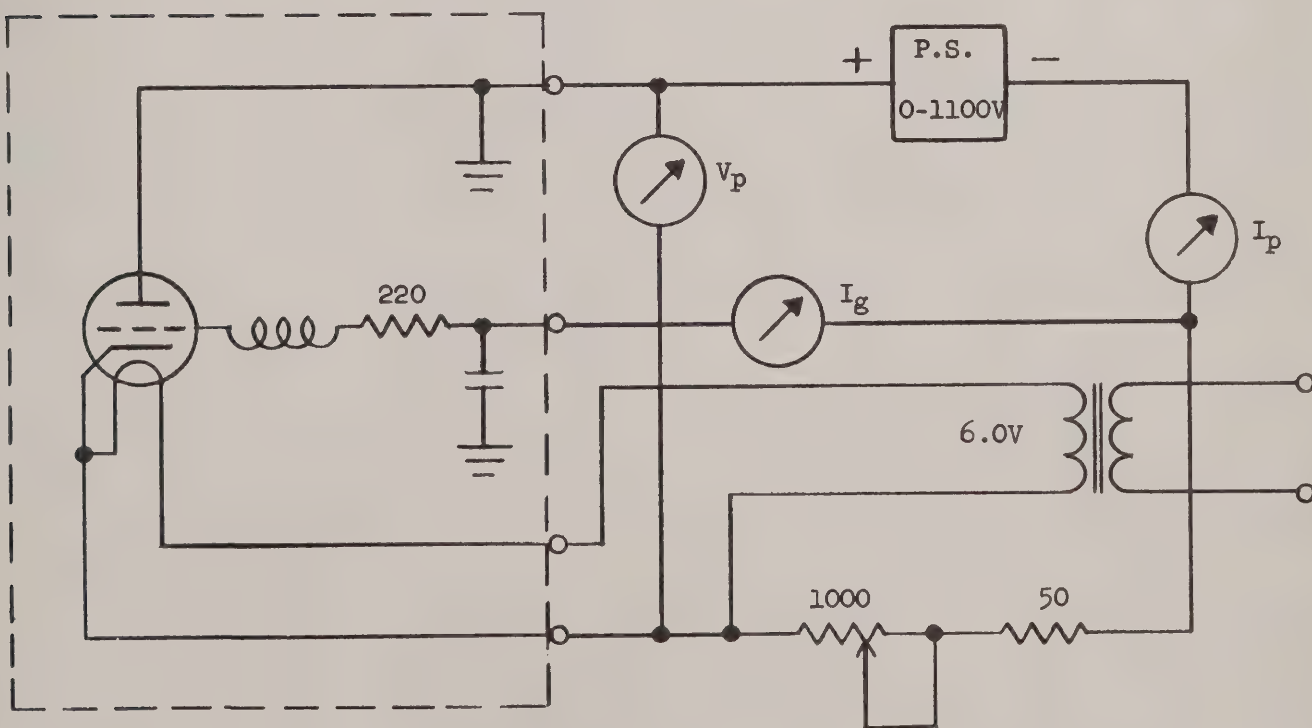
(2) Knobs are provided on the front panel for fine tuning the plate and cathode cavities and for adjusting output coupling. Frequency scales are provided for each cavity. Tuning is accomplished by sliding the pointers to the desired frequency, then adjusting the fine tuning and output coupling. Access to the interior of the amplifier is not required for tuning. Four sets of scales are provided, covering four sections of the tuning range. The desired set of scales is selectable by a knob on the front panel.

(3) If ambient temperature exceeds 90°F, the cavity body will become quite hot (up to 250°F), and forced air cooling is recommended.

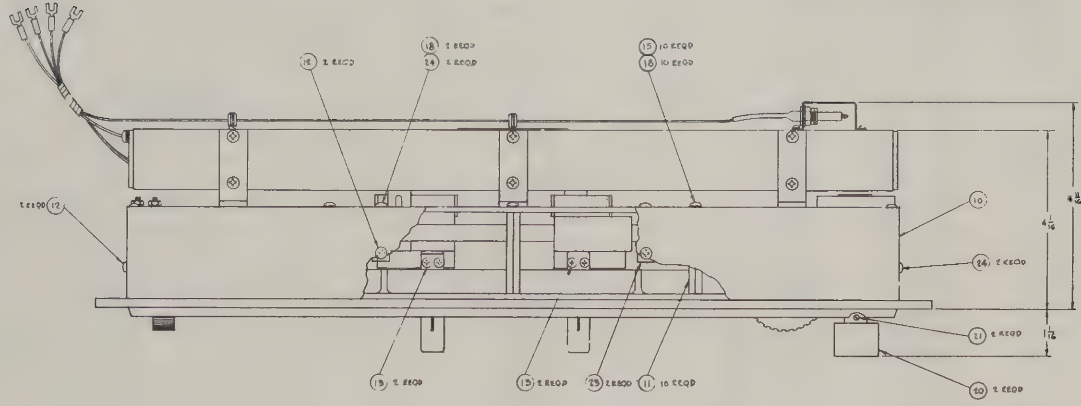
For personnel protection, high voltage circuits above 500 volts are enclosed and identified. Interlocks are not provided.

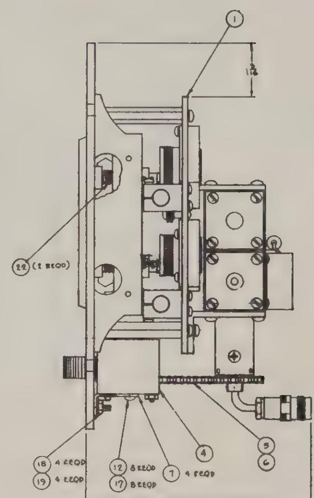


EM4512A CAVITY OSCILLATOR
Figure 2

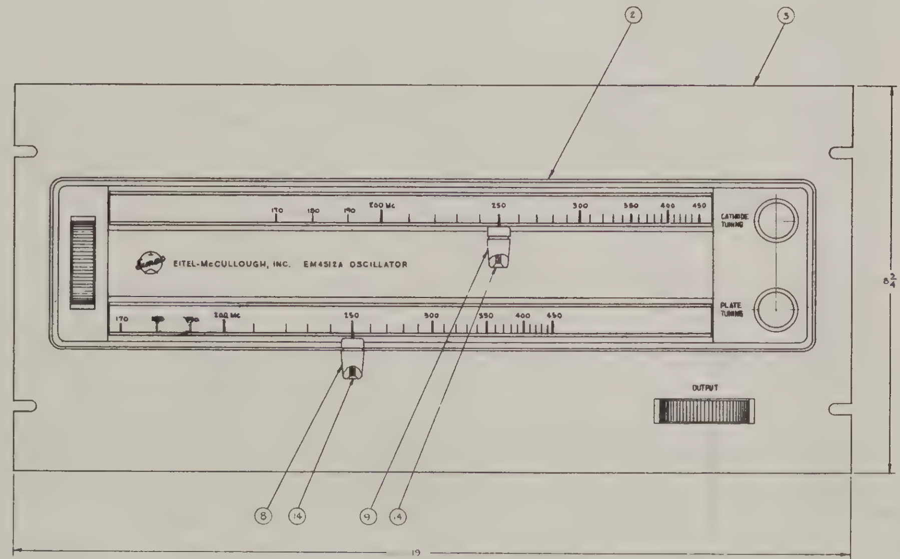


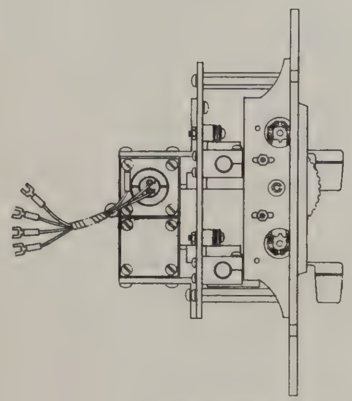
EM4512A POWER SUPPLY CONNECTIONS
Figure 3





VIEW WITH COVER-ITEM 10 REMOVED





VIEW WITH COVER-ITEM 10 REMOVED

NOTE:
1. DIMENSIONS ARE NOMINAL AND ARE FOR REFERENCE ONLY.

ITEM	QTY	PART NUMBER	DESCRIPTION
24	6		SCREW, PAN HD, PH DR #6-32 x 1/4 LG
23	2	PR-14563	BRACKET-COVER
22	2		SPRING-LEE #LC-022D-5 (SST)
21	2		SCREW, SET-HEX SKT HD, #4-40 x 1/8 LG
20	2	PR-14143	KNOB ASSY
19	4		NUT, HEX-#6-32
18	16		LOCKWASHER, SPLIT #6
17	8		LOCKWASHER, SPLIT #4
16	4		SCREW PAN HD, PH DR-#8-32 x 3/16 LG
15	10		SCREW, PAN HD PH DR-#6-32 x 1/2 LG
14	2		SCREW, FLAT HD-82°, PH DR-#4 40 x 3/8 LG
13	4		SCREW, BDG HD, PH DR-#4-40 x 1/4 LG
12	12		SCREW, BDG HD, PH DR-#4-40 x 3/16 LG
11	10	PR-14121	SPACER-MTG
10	1	PR-14431	COVER
9	1	PR-14214	SLIDER ASSY-CATHODE CAVITY
8	1	PR-14149	SLIDER ASSY-PLATE CAVITY
7	4	PR-14102	BRACKET, DRIVE
6	1	S18043N	DISCONNECT ASSY
5	A/R		CHAIN-SIERRA 1675 P-SST
4	1	PR-11998	DRIVE ASSY-OUTPUT COUPLER
3	1	PR-14248	PANEL ASSY
2	1	PR-14397	BEZEL ASSY
1	1	PR-14351	CAVITIES & DRIVE ASSY

Eimac®

EITEL-McCULLOUGH, INC.

Tentative Data

EM4527

TELEMETRY TRANSMITTER

2200 - 2300 Mc
2 Watts

Eitel-McCullough S-Band transmitters provide over 2 watts rf output with over 10% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. They are designed to operate during the severe shock and vibration of missile launch.

Model EM 4527 is a complete transmitter, including a pre-regulated DC-DC converter. All circuits are solid state, except the rf power oscillator, which is a single stage rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter is packaged in less than 50 cubic inches, and weighs less than 4 pounds. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 2.2-2.3 Gc band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range —40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 Mc is accomplished at ±2.5% linearity, and ±300Kc at ±0.5% linearity.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	2200-2300 Mc
Power Output, CW Minimum	2 Watts
Frequency Accuracy	±0.001%
Frequency Stability	±0.001%
Carrier Deviation, Adjustable, peak-to-peak	2Mc/Volt to 30Kc/Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 cps to 500 Kc
Flat within ±1 db	5 cps to 800 Kc
Modulation Linearity, Deviation from B.S.L.,	
For ±300 Kc peak Deviation	±0.5%
For ±1.5 Mc peak deviation	±2.5%
Incidental Frequency Modulation, Maximum	3.5 Kc rms
AM, Maximum, due to environmental conditions	1%
due to ±300 Kc carrier deviation	1%
due to ±1.5 Mc carrier deviation	5%
Modulation Input Impedance, Minimum, 5 cps to 800 Kc	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	700 mA
Primary Ripple, maximum, peak-to-peak from Dc to 20 Kc	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
Input current rise above nominal, due to fault[3] maximum	130%
VSWR Maximum, any phase, for 2 watts output	1.5:1
for 1 watt output	5.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	500 hours

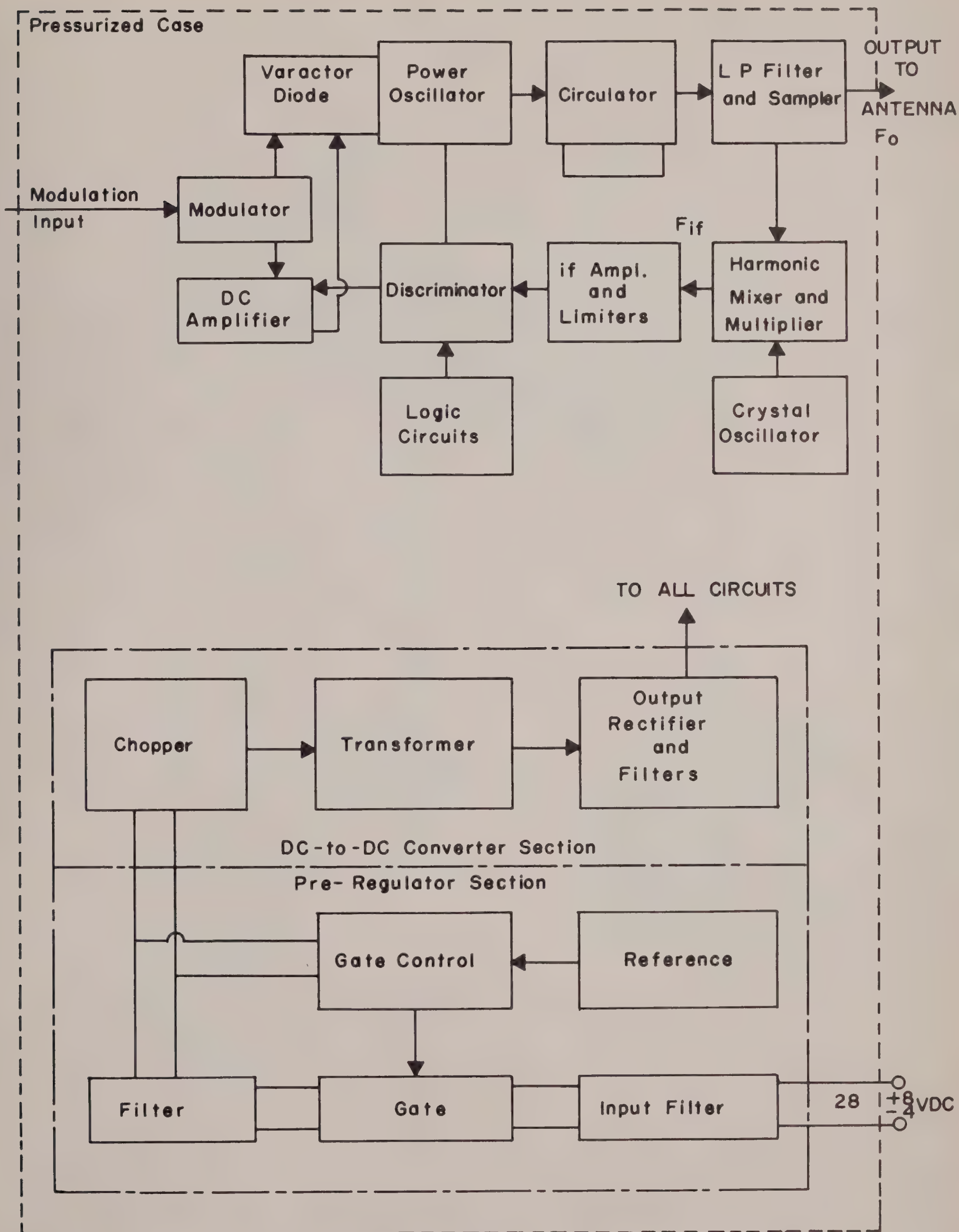
PACKAGING

Volume displaced	48 cubic inches
Dimensions, including mounting flanges	6.5" x 4.4" x 1.9"
Weight	4 pounds
Pressurization (will maintain within 75% for 1 year)	30 psia
Cooling	Conduction to heat sink

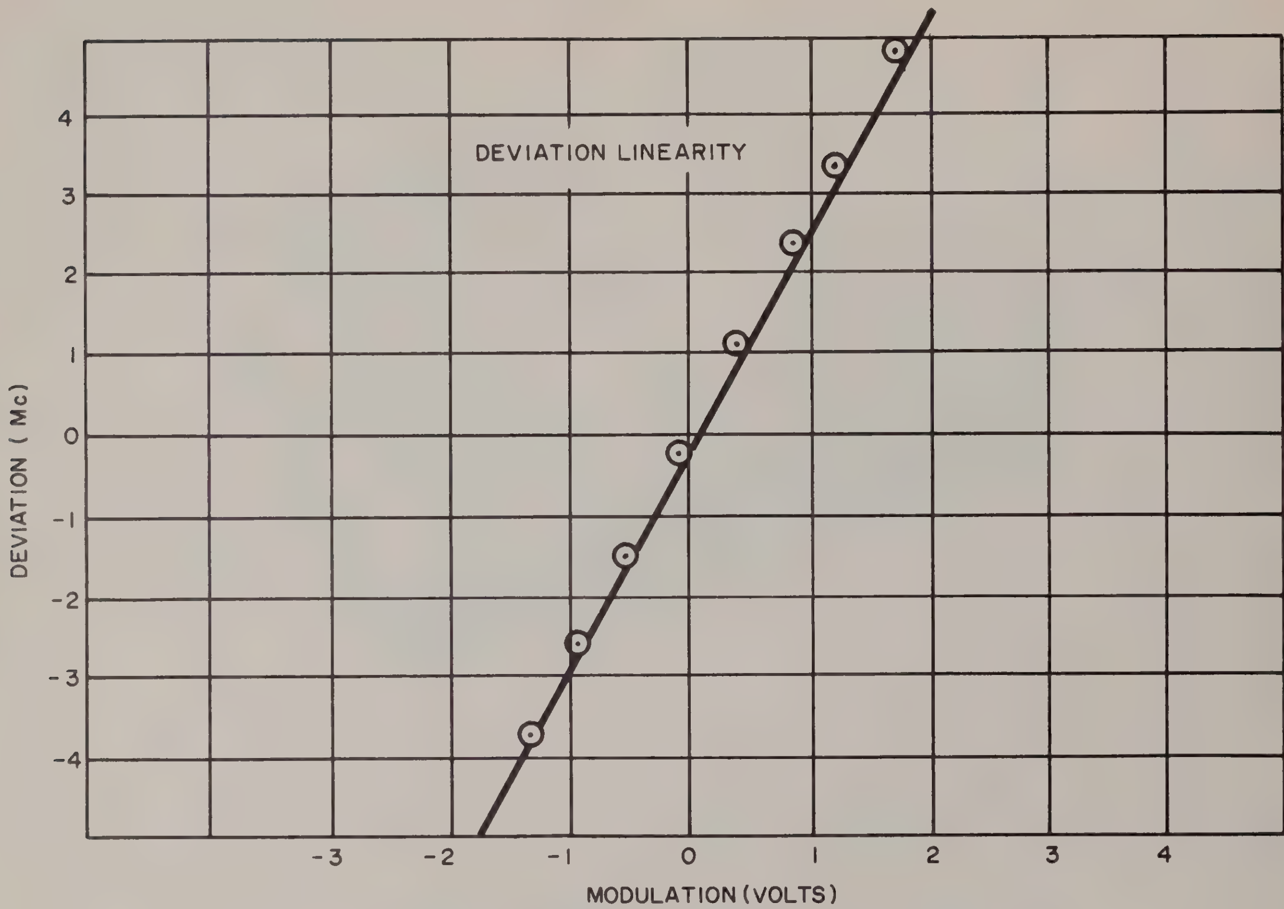
ENVIRONMENTAL SPECIFICATIONS[4]

Temperature[5] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration (MIL-STD-810, Figure 514-3 Curve D)	15G peak to 2 Kc
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/cps
Air Induced Vibration	150 db above 2×10^{-4} dynes/CM^2 from 150 to 2000 cps, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration	30G for 5 minutes, three axes
Shock, per MIL-STD-810 Method 516, Procedures I and V,	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[6]	100G

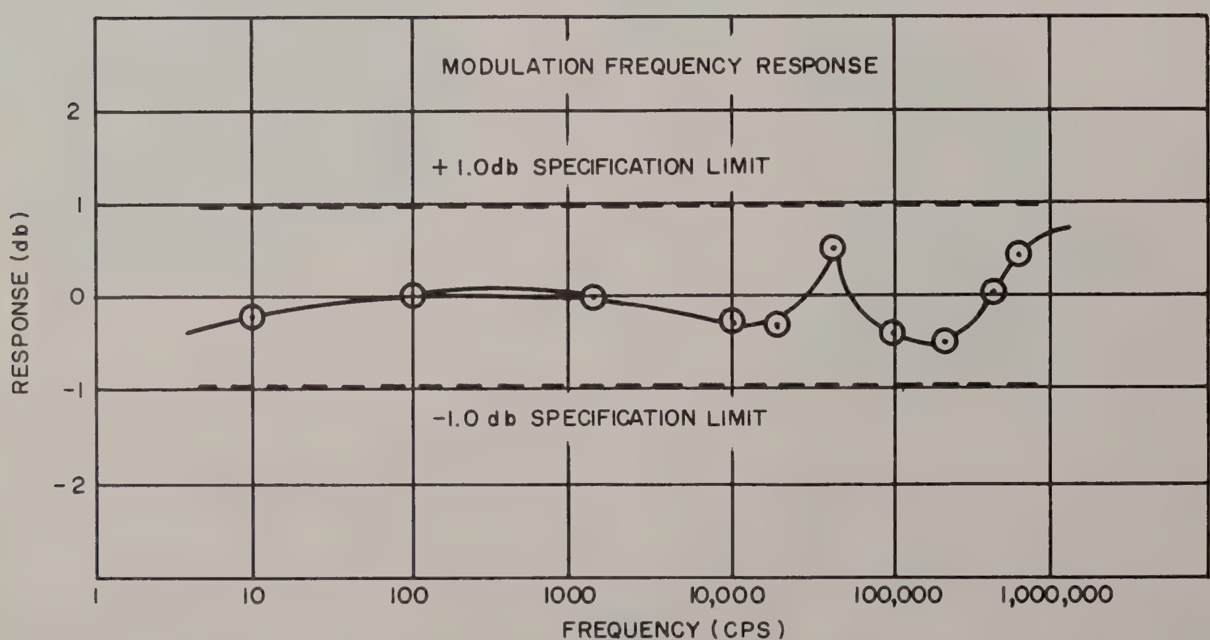
[6]Out-of-tolerance operation may occur during 100G shock.
[5]Other ranges available on special order.
[4]Transmitter performs as specified, under any combination of environmental conditions.
[3]Any failure of transmitter (except at input terminals).
[2]Under emergency conditions, full rf output is provided with primary power as low as 20 Vdc, but increased IFM and AM will occur.
[1]Also available modified for modulation down to DC.



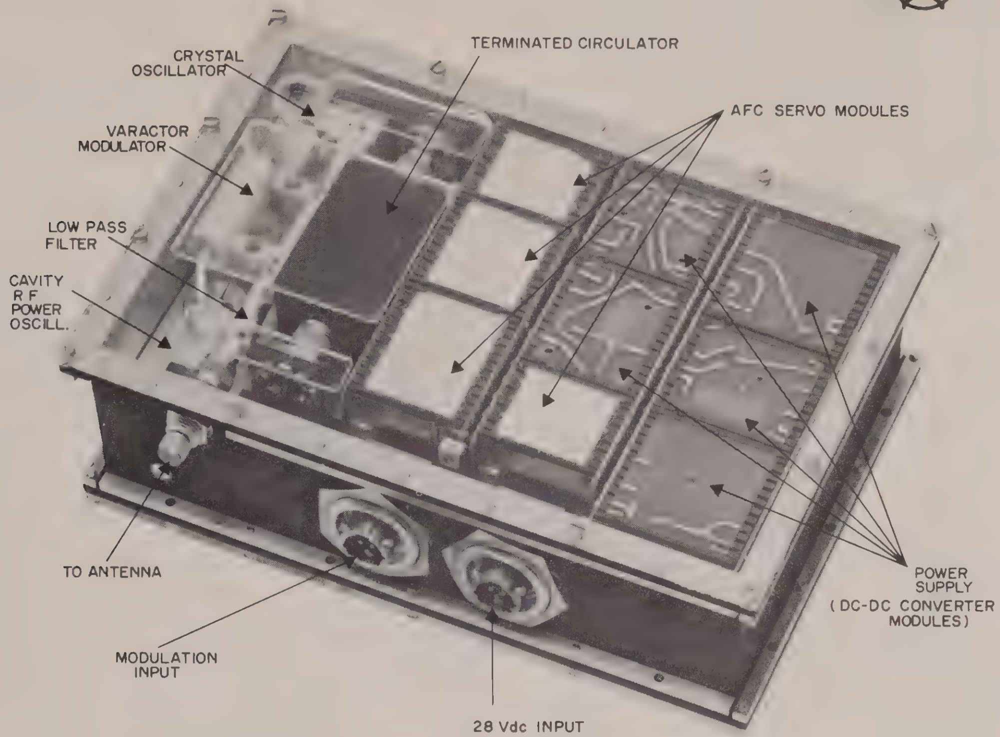
BLOCK DIAGRAM
MODEL EM4527 2W S-BAND TELEMETRY TRANSMITTER



DEVIATION LINEARITY OF EM4527 TRANSMITTER

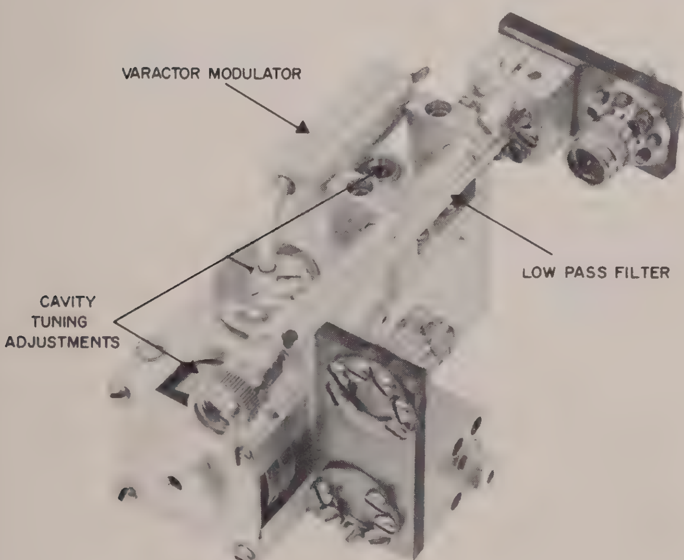


MODULATION FREQUENCY RESPONSE OF EM4527 TRANSMITTER



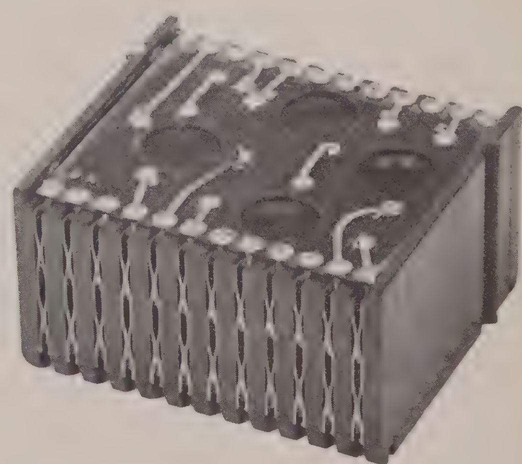
EM4527 TELEMETRY TRANSMITTER ASSEMBLY

Packaging of this transmitter is compact, yet all modules are easily accessible by removing top and bottom covers. The covers incorporate pressure seals and rfi gaskets.



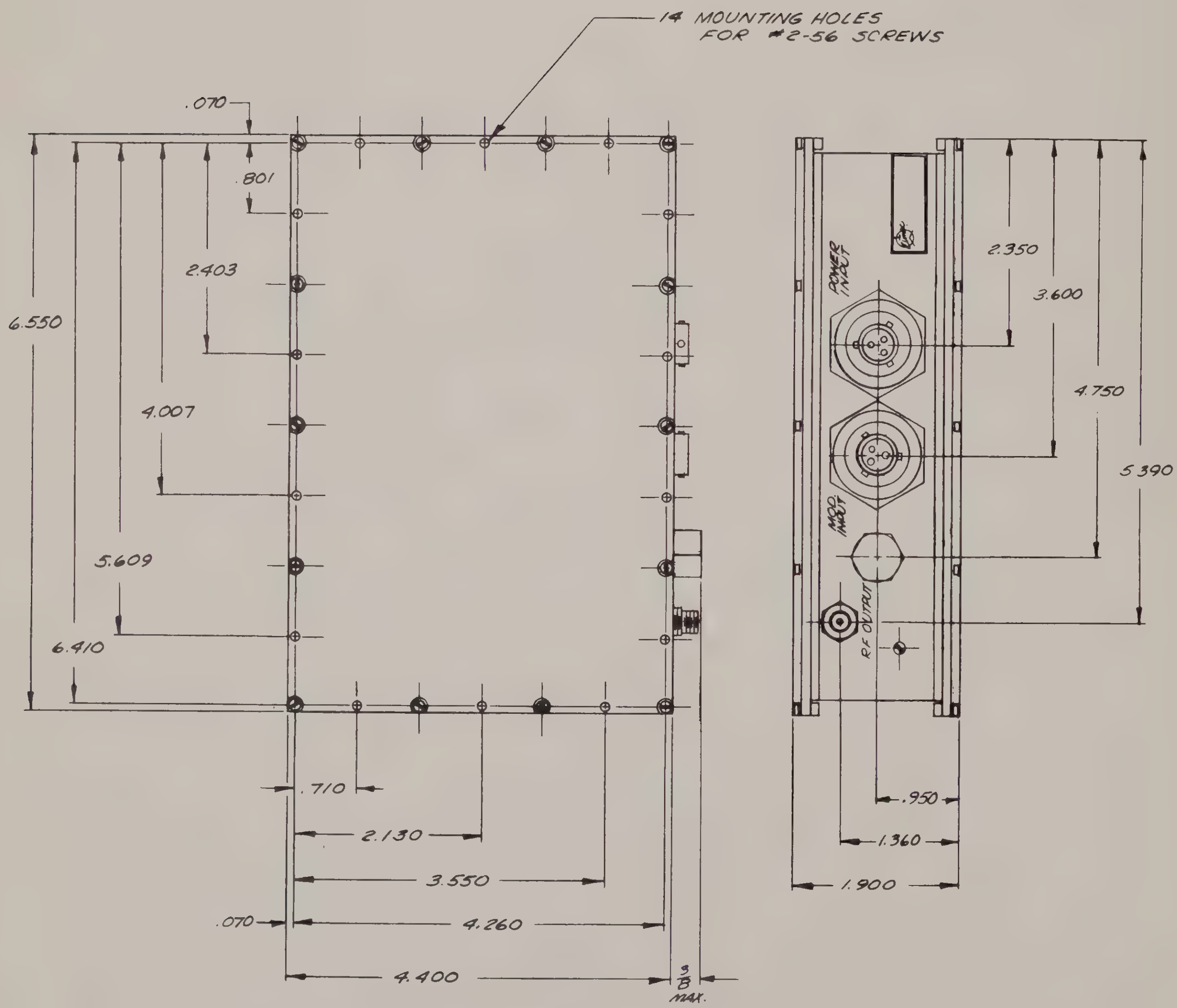
RF SECTION, EM4527 TRANSMITTER

The rf power oscillator provides over 2 watts, tunable 2.2-2.3 Gc. There is no output below 2.2 Gc. Harmonics are removed by a low pass filter. The ceramic planar triode in the oscillator is conduction cooled to the transmitter case.



TYPICAL PLUG-IN MODULE

Circuits use only high reliability components such as silica planar transistors and are packaged in modular form. The modules are easily removable, and offer flexibility for future modification. The connector system provides four redundant contacts at each connection. All modules are encapsulated with a rigid high thermal conductivity compound for heat conduction and vibration protection.


14 MOUNTING HOLES
FOR #2-56 SCREWS
.070
.801
2.403
4.007
5.609
6.410
6.550
.710
2.130
3.550
.070
4.260
4.400
3/8 MAX.
POWER INPUT
MOD INPUT
R.F. OUTPUT
2.350
3.600
4.750
5.390
.950
1.360
1.900

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EM-1102A
PULSED
TRAVELING WAVE TUBE
4.5-6.5 GHz
100W Peak

The EM1102A is a grid modulated pulse TWT designed for use in airborne and missle environments. It delivers 100W peak saturation output power over the band 4.5-6.5 GHz. The EM1102A is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	5.0 kV
Cathode Current	350 mA
Grid Bias Voltage	-150V
Duty Cycle	6%
Pulse Duration	100 μs
Heater Voltage	6.8V
Heater Surge Current	4.0A
Source VSWR	1.8 : 1
Load VSWR	2.0 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	4.5-6.5 GHz
Peak Output, (Min)	100W
Gain for 100W Output, (Min)	36 dB
Heater Voltage	6.3V
Heater Current, Typ	1.4A
Heater Warm-Up Time (Min)	3.0 min
Grid Capacitance (To all other elements)	30 pF
Grid Bias Voltage	-60V
Grid Drive Voltage[5]	+140V

PHYSICAL

Dimensions	See Outline
Weight, Approx.	5 lb
Mounting Position	Any
RF Connectors	Type "N"

TYPICAL OPERATING CONDITIONS[2,3]

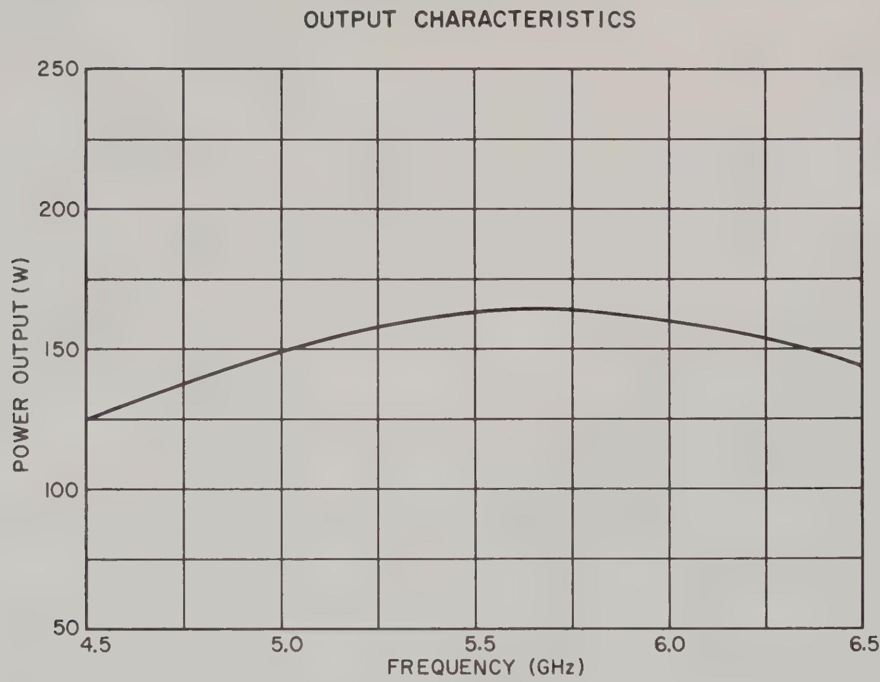
Output	See Curves
Gain	See Curves
Beam Voltage	4400V
Cathode Current, Peak	300 mA
Grid Bias Voltage	-60V
Grid Current, Peak	20 mA
Duty	6%
Pulse Duration	80 μs
Load VSWR	2.0 : 1

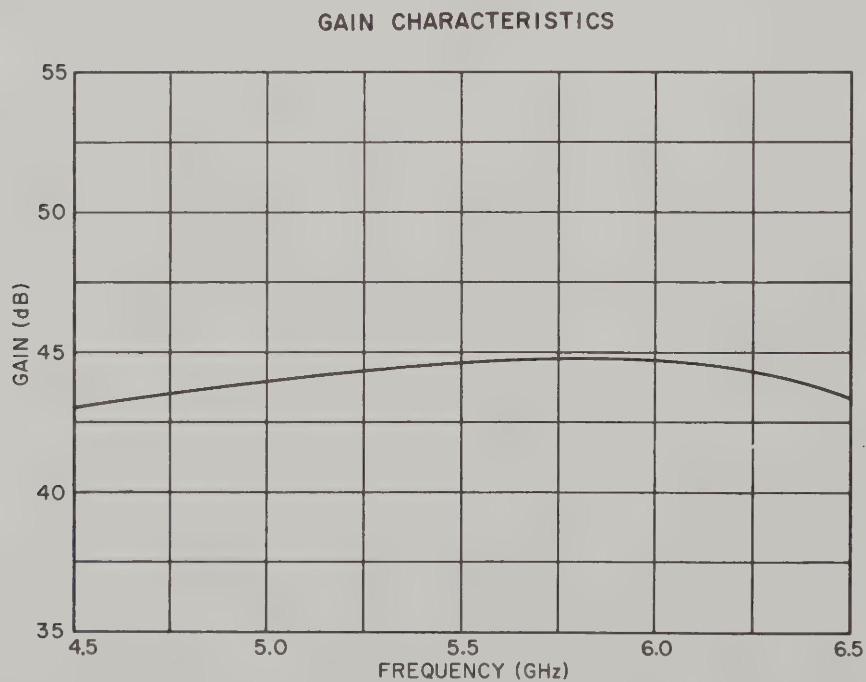
RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

	Min.	*Max.*
Beam Voltage	4000	5000 V
Cathode Current Peak	200	350 mA
Grid Current	0	50 mA
Heater Voltage	6.8	6.8V
Heater Current	1.0	1.6A
Grid Voltage	-50	-150V

(See Footnotes on Page 2)

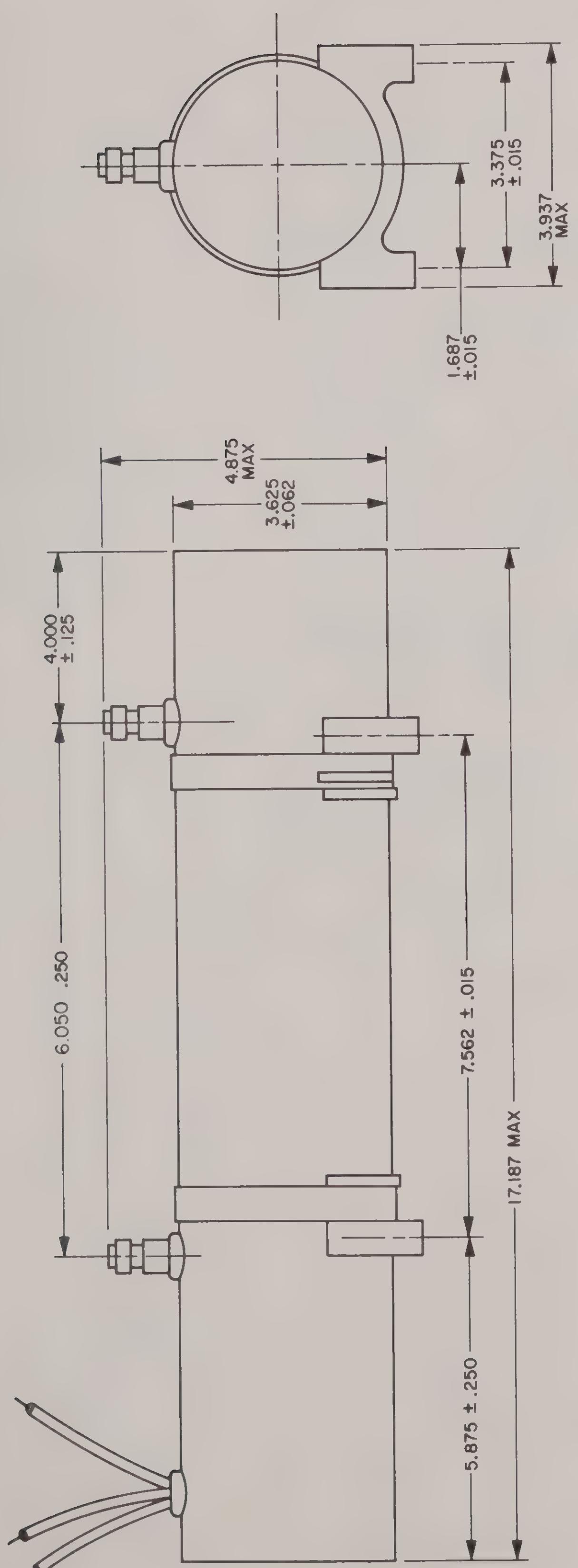
NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.





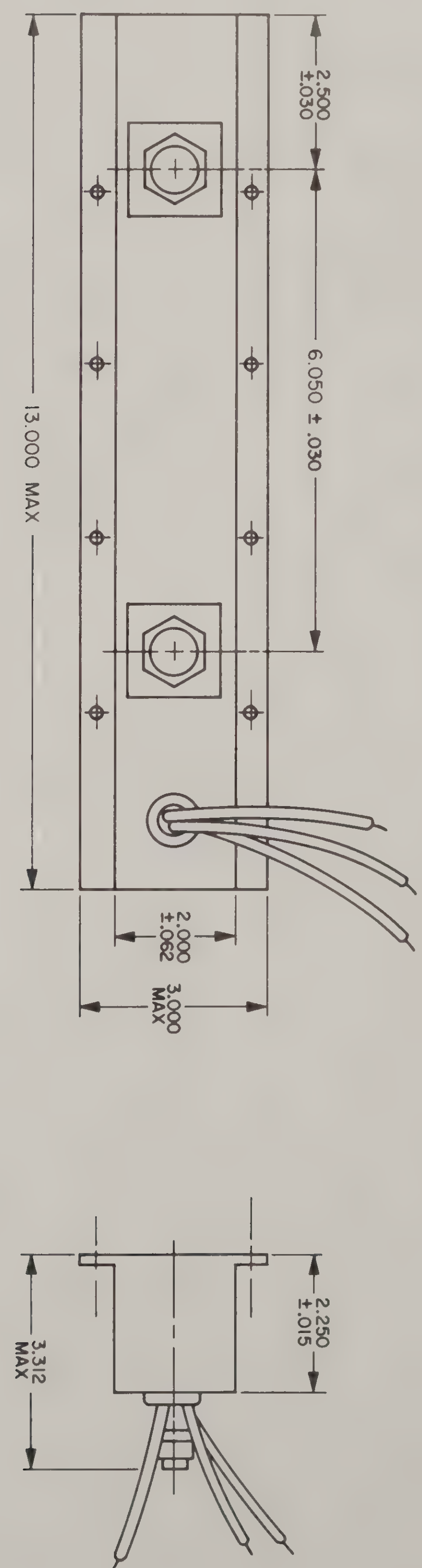
1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.
3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.
4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range.
5. Voltage reference: grid to cathode.

CONVECTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

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EM-1102B
PULSED
TRAVELING WAVE TUBE
5.4-5.9 GHz
50W Peak

The EM1102B is a grid modulated pulse TWT designed for use in airborne and missle environments. It delivers 50W peak saturation output power over the band 5.4-5.9 GHz. The EM1102B is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	3300V
Cathode Current	250 mA
Grid Bias Voltage	-120V
Duty Cycle	6%
Pulse Duration	100 μs
Heater Voltage	6.8V
Heater Surge Current	4.0A
Source VSWR	1.8 : 1
Load VSWR	2.0 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	5.4-5.9 GHz
Peak Output, (Min)	50W
Gain for 50W Output, (Min)	50 dB
Heater Voltage	6.3V
Heater Current, Typ	1.4A
Heater Warm-Up Time (Min)	3.0 min
Grid Capacitance (To all other elements)	30 pF
Grid Bias Voltage	-60V
Grid Drive Voltage[5]	+100V

PHYSICAL

Dimensions	See Outline
Weight, Approx.	5 lb
Mounting Position	Any
RF Connectors	Type "N"

TYPICAL OPERATING CONDITIONS[2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	3000V
Cathode Current, Peak	200 mA
Grid Bias Voltage	-60V
Grid Current, Peak	20 mA
Duty	6%
Pulse Duration	80 μs
Load VSWR	1.8 : 1

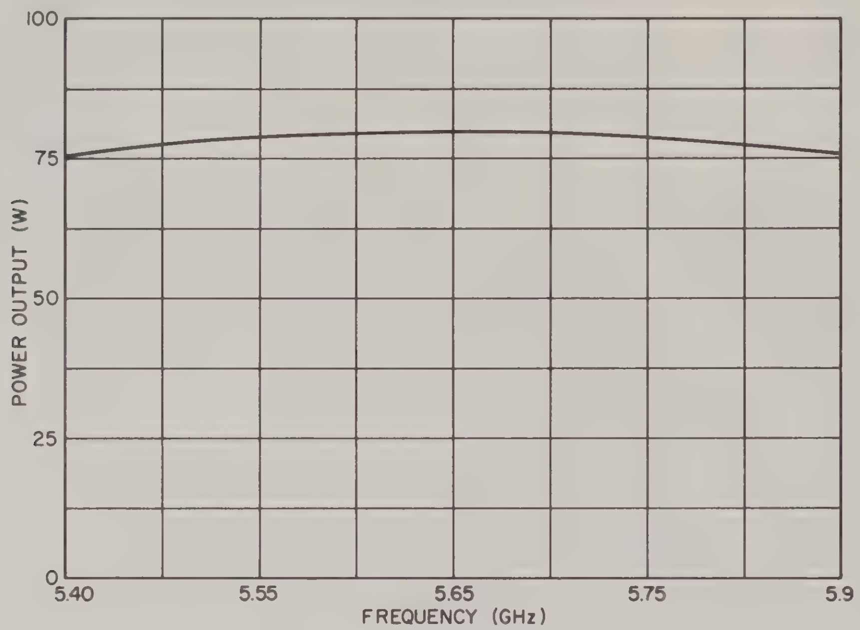
RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

	Min.	*Max.*
Beam Voltage	2700	3300 V
Cathode Current Peak	150	250 mA
Grid Current	0	30 mA
Heater Voltage	5.8	68V
Heater Current	1.0	1.6A
Grid Voltage	-80	-120V

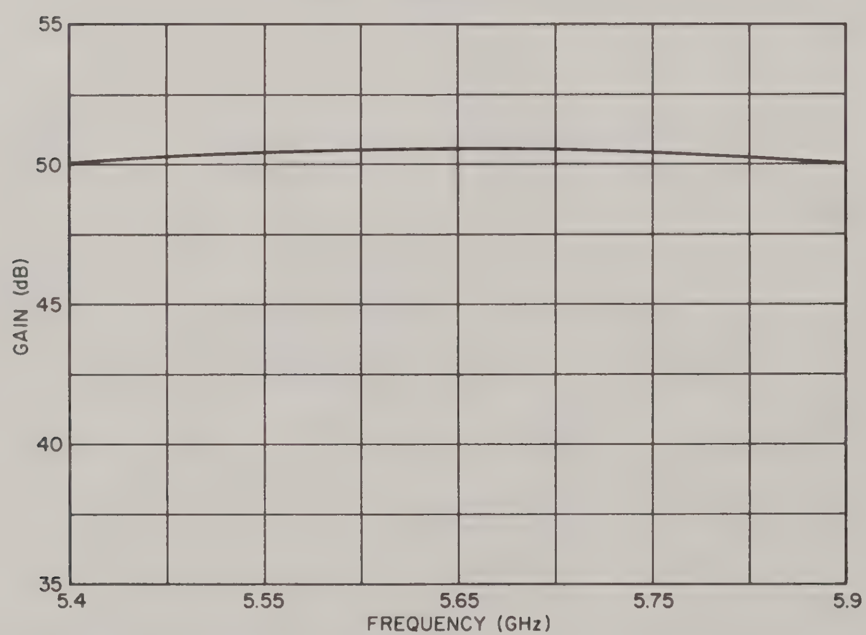
(See Footnotes on Page 2)

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

OUTPUT CHARACTERISTICS

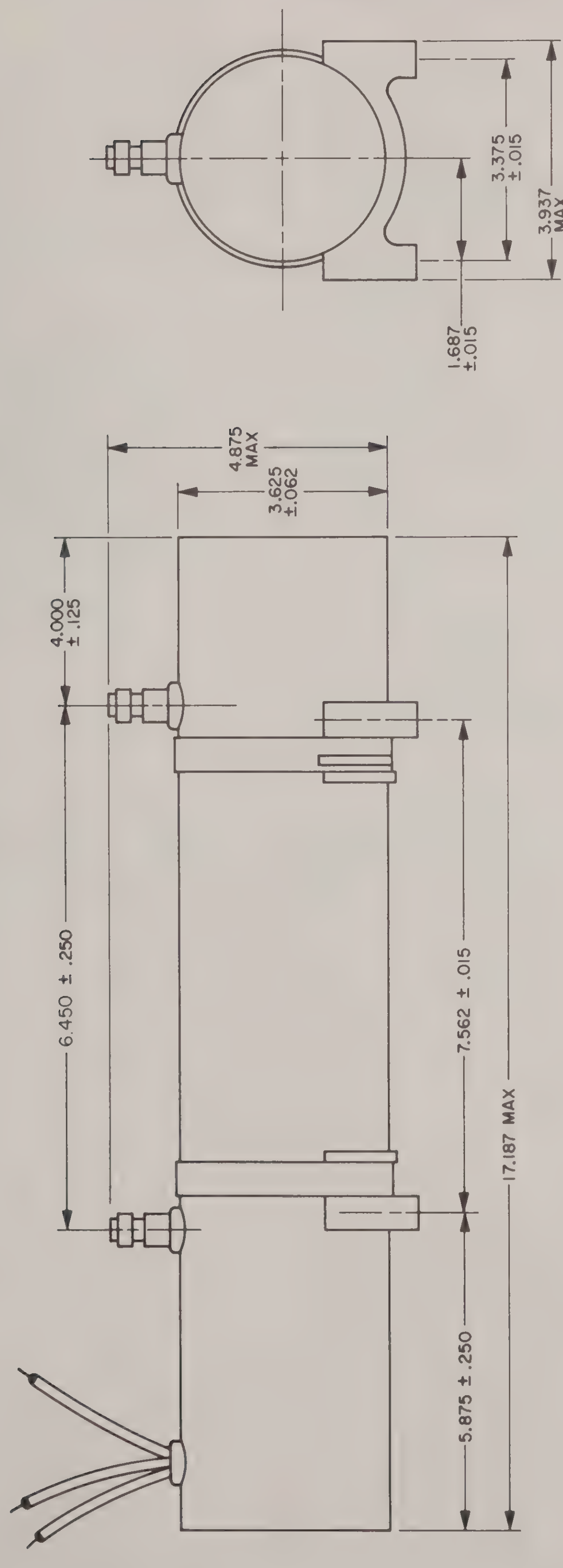


GAIN CHARACTERISTICS



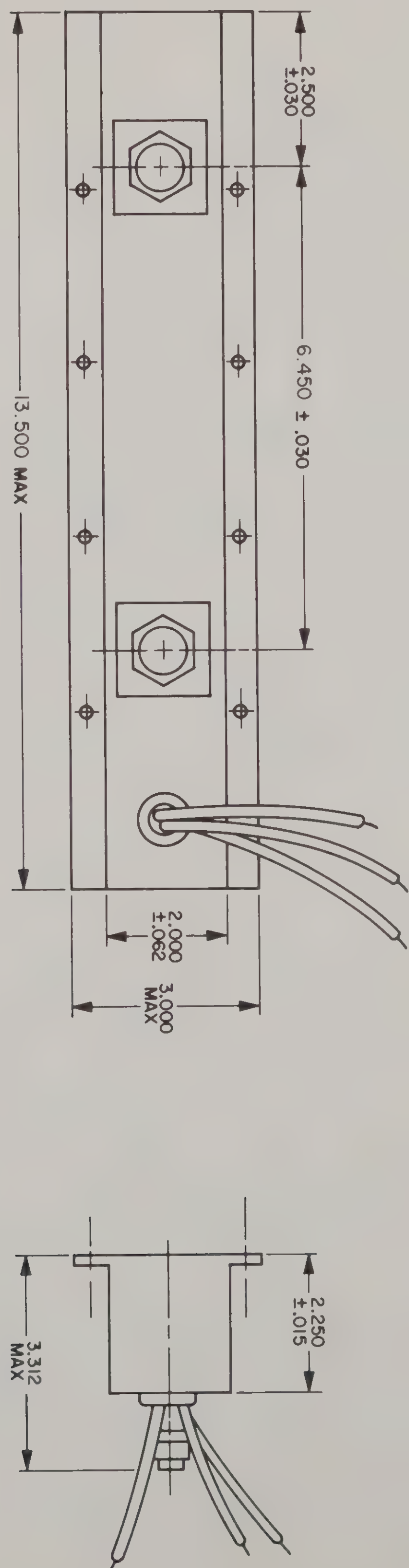
1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.
3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.
4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range of 1.2-1.5 GHz.
5. Voltage reference: grid to cathode.

CONVECTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

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EM-108
PULSED
TRAVELING WAVE TUBE
2.0-4.0 GHz
1.0 kW Peak

The EM108 is a grid modulated pulse TWT designed for use in airborne and missile environments. It delivers 1.0 kW peak saturation output power over the band 2.0-4.0 GHz. The EM108 is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	8.0 kV
Cathode Current	1.8A
Grid Bias Voltage	-300V
Duty Cycle	2%
Pulse Duration	10 μs
Heater Voltage	6.8V
Heater Surge Current	5.0A
Source VSWR	2.0 : 1
Load VSWR	2.5 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	2.0-4.0 GHz
Peak Output, (Min)	1.0 kW
Gain for 1.0 kW Output, (Min)	36 dB
Heater Voltage	6.3V
Heater Current, Typ	1.6A
Heater Warm-up Time (Min)	3.0 min
Grid Capacitance (To all other elements)	40.0 pF
Grid Bias Voltage	-100V
Grid Drive Voltage[5]	+250V

PHYSICAL

Dimensions	See Outline
Weight, Approx.	7.5 lb
Mounting Position	Any
RF Connectors	TNC

TYPICAL OPERATING CONDITIONS[2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	7.6 kV
Cathode Current, Peak	1.3A
Grid Bias Voltage	-100V
Grid Current, Peak	150 mA
Duty	2%
Pulse Duration	8 μs
Load VSWR	2.0 : 1

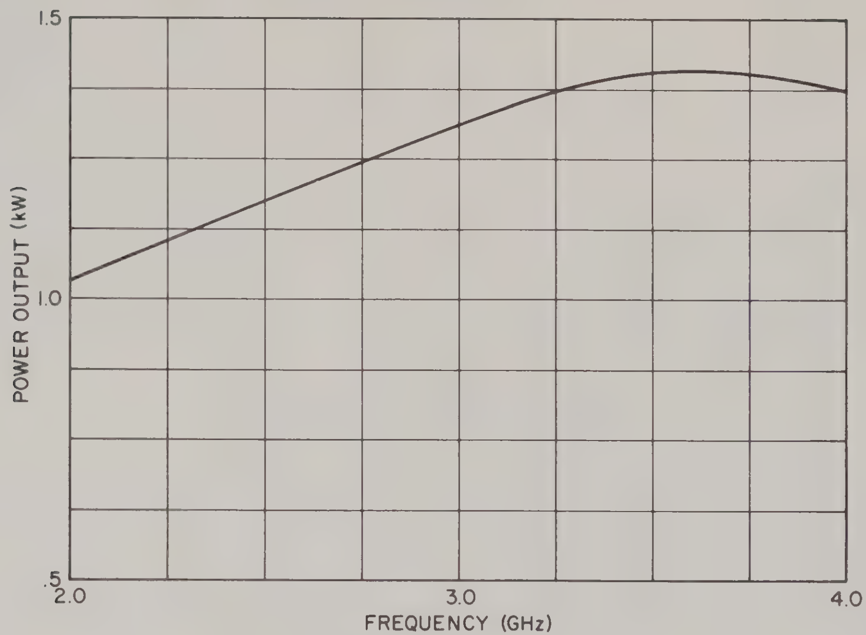
RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

	Min.	*Max.*
Beam Voltage	7.0	8.0 kV
Cathode Current Peak	1.0	1.8A
Grid Current	100	250 mA
Heater Voltage	5.8	6.8V
Heater Current	1.0	2.5A
Grid Voltage	-80	-300V

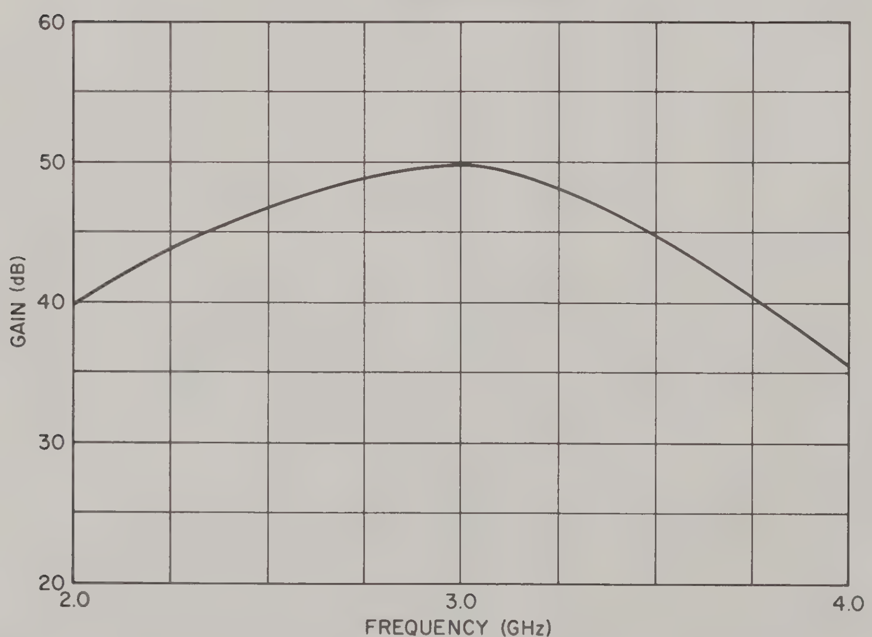
(See Footnotes on Page 2)

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

OUTPUT CHARACTERISTICS



GAIN CHARACTERISTICS



1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.

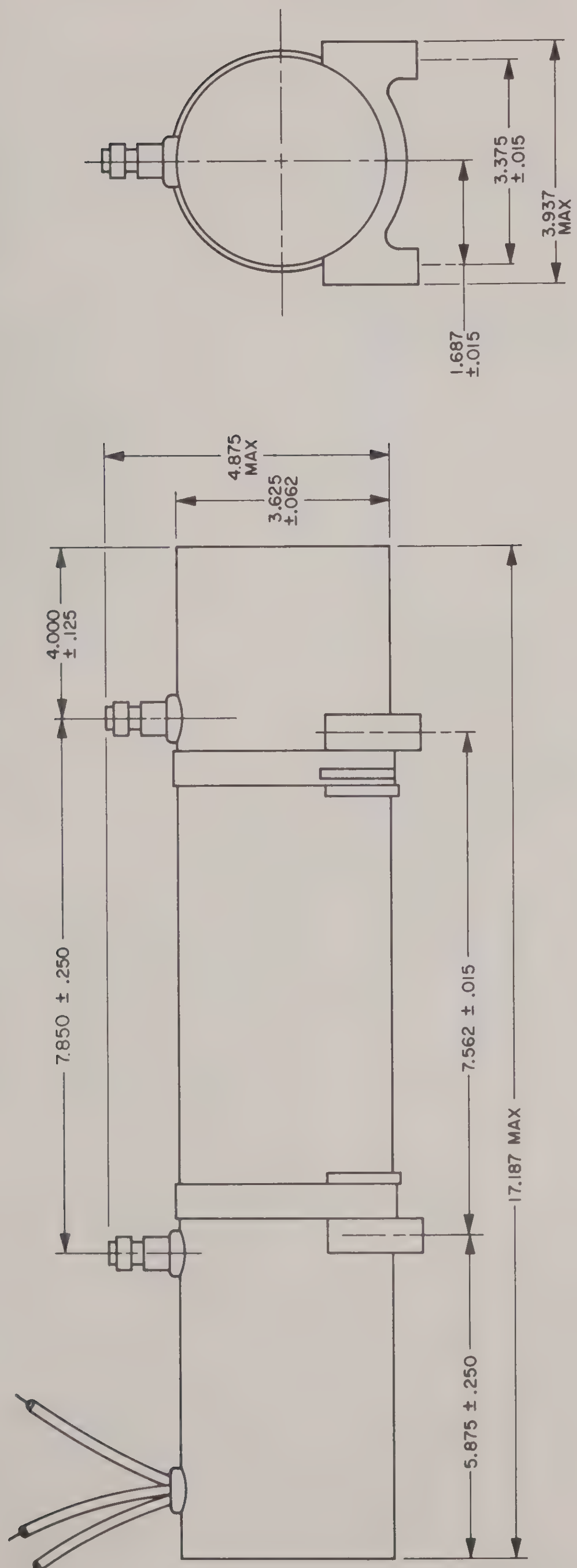
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.

3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.

4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range.

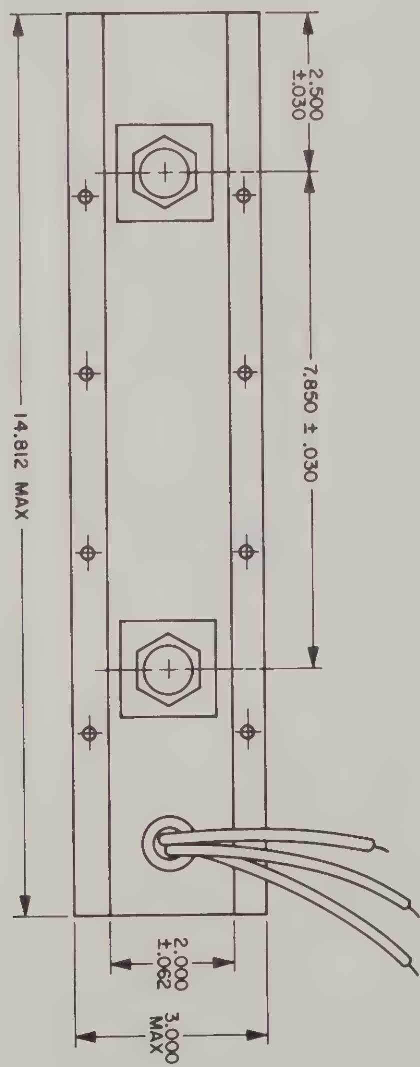
5. Voltage reference: grid to cathode.

CONVECTION COOLED

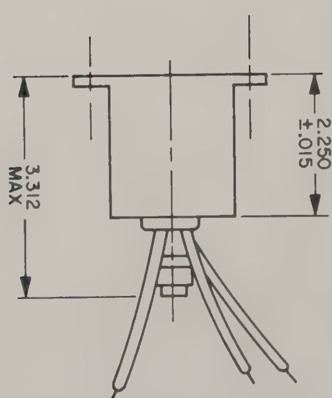


LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER/CATHODE



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EM-113
PULSED TRAVELING WAVE TUBE
2.0-4.0 GHz
1.0 kW Peak

The EM113 is a pulse TWT designed for use in airborne and missile environments. It delivers 1.0 kW peak saturation output power over the band 2.0-4.0 GHz. The EM113 is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	8 kV
Cathode Current	1.8A
Duty Cycle	2%
Pulse Duration	10 μs
Heater Voltage	6.8V
Heater Surge Current	3.6A
Source VSWR	2.0 : 1
Load VSWR	2.5 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	2.0-4.0 GHz
Peak Output, (Min)	1.0 kW
Gain for 1.0 kW Output, (Min)	30 dB
Heater Voltage	6.3V
Heater Current, Typ	1.6A
Heater Warm-Up Time (Min)	3.0 min

PHYSICAL

Dimensions	See Outline
Weight, Approx	10 lb
Mounting Position	Any
RF Connectors	TNC

TYPICAL OPERATING CONDITIONS[2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	7.3 kV
Cathode Current, Peak	1.3A
Duty	1%
Pulse Duration	8 μs
Load VSWR	2.0 : 1

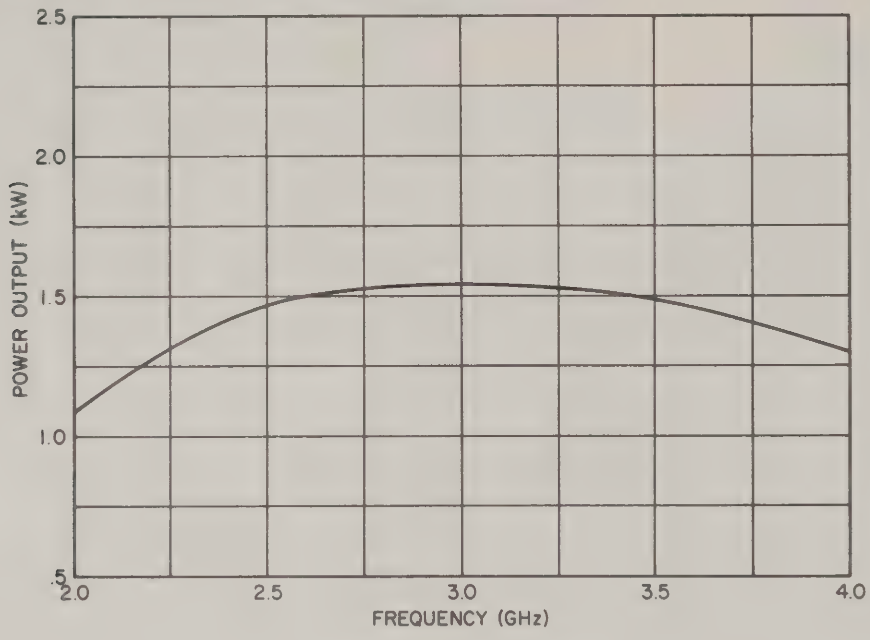
RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

	Min.	*Max.*
Beam Voltage	6.8	8.0 kV
Cathode Current Peak	1.0	1.8A
Heater Voltage	6.8	6.8V
Heater Current	1.2	1.8A

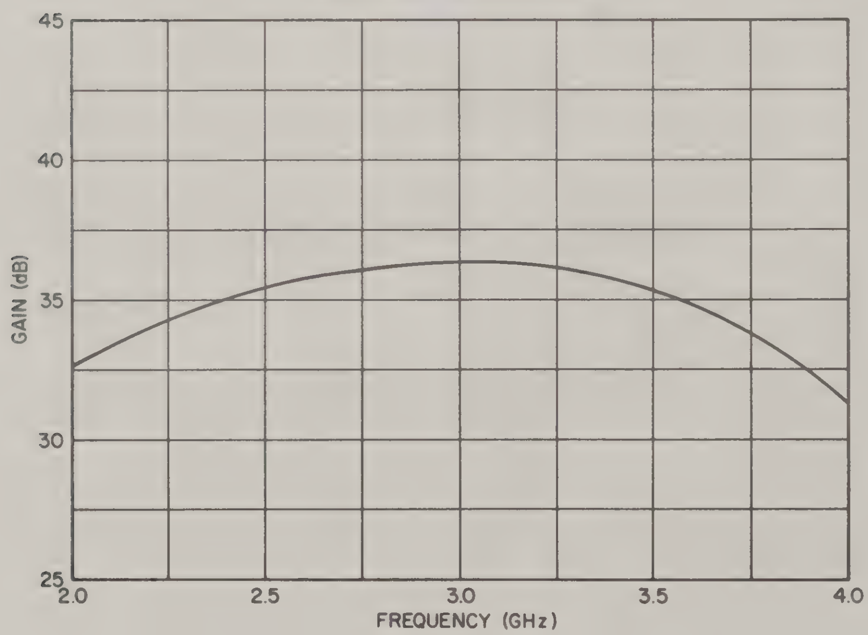
(See Footnotes on Page 2)

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

OUTPUT CHARACTERISTICS



GAIN CHARACTERISTICS



NOTES

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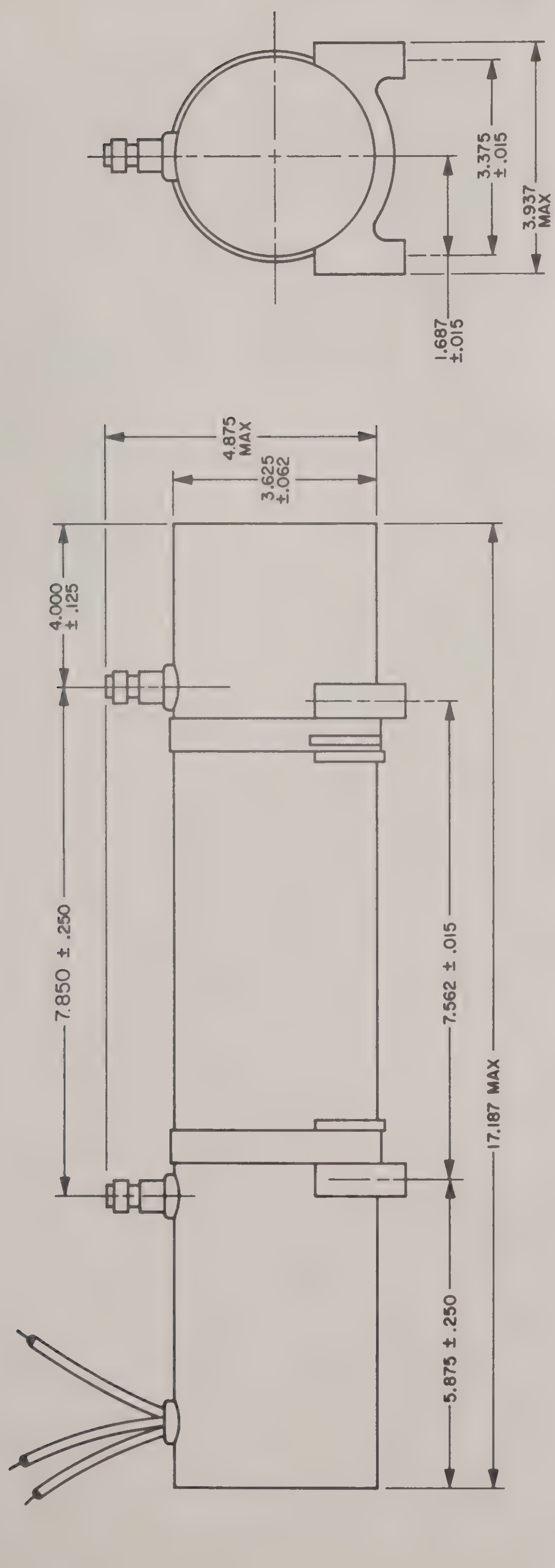
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.

3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.

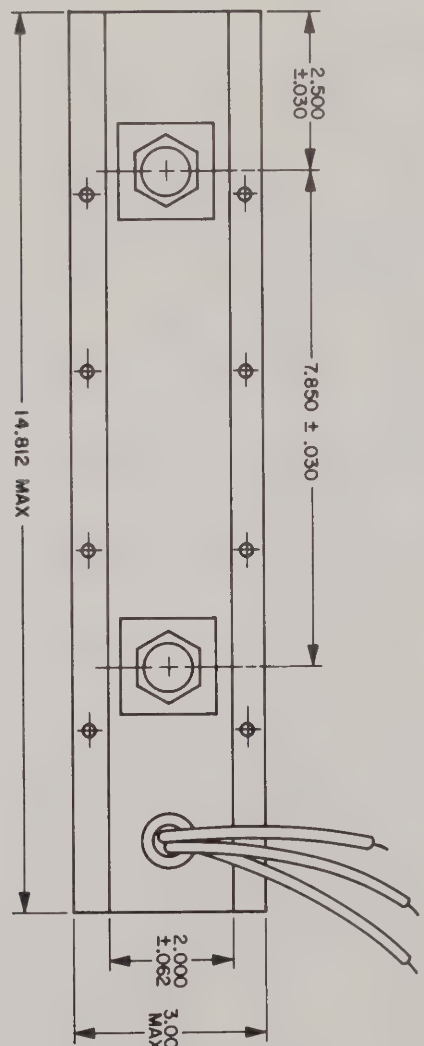
4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range.

CONVECTION COOLED

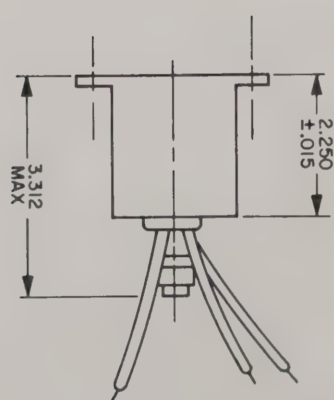


LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER CATHODE



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EM-114A

PULSED
TRAVELING WAVE TUBE
2.70-2.90 GHz
2.0 kW Peak

The EM114A is a grid modulated pulse TWT designed for use in airborne and missile environments. It delivers 2.0 kW peak saturation output power over the band 2.70-2.90 GHz. The EM114A is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS [1]

Beam Voltage	8.5 kV
Cathode Current	1.8A
Grid Bias Voltage	-300V
Duty Cycle	2%
Pulse Duration	10 μs
Heater Voltage	6.8V
Heater Surge Current	5.0A
Source VSWR	2.0 : 1
Load VSWR	2.5 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	2.70-2.90 GHz
Peak Output, (Min)	2.0 kW
Gain for 2.0 kW Output, (Min)	30 dB
Heater Voltage	6.3V
Heater Current, Typ	1.6A
Heater Warm-up Time (Min)	3.0 min
Grid Capacitance (To all other elements)	40.0 pF
Grid Bias Voltage	-100V
Grid Drive Voltage[5]	+250V

PHYSICAL

Dimensions	See Outline
Weight, Approx.	8 lb
Mounting Position	Any
RF Connectors	TNC

TYPICAL OPERATING CONDITIONS [2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	8.2 kV
Cathode Current, Peak	1.4A
Grid Bias Voltage	-200V
Grid Current, Peak	150 mA
Duty	2%
Pulse Duration	8 μs
Load VSWR	2.0 : 1

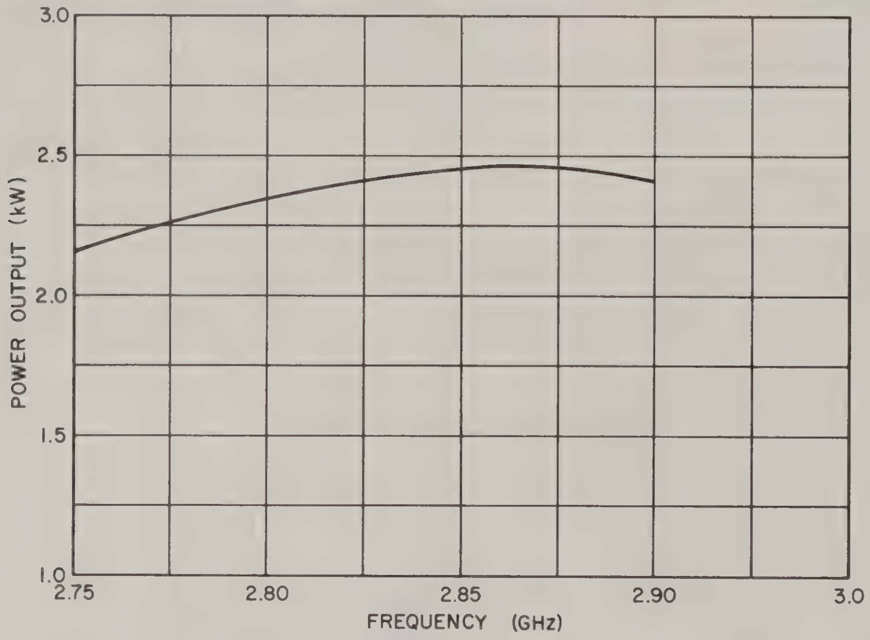
RANGE VALUES FOR EQUIPMENT DESIGN [2,4]

	Min.	*Max.*
Beam Voltage	7.5	8.5 kV
Cathode Current Peak	1.0	1.8A
Grid Current	120	250 mA
Heater Voltage	5.8	6.8V
Heater Current	1.0	2.5A
Grid Voltage	-150	-300V

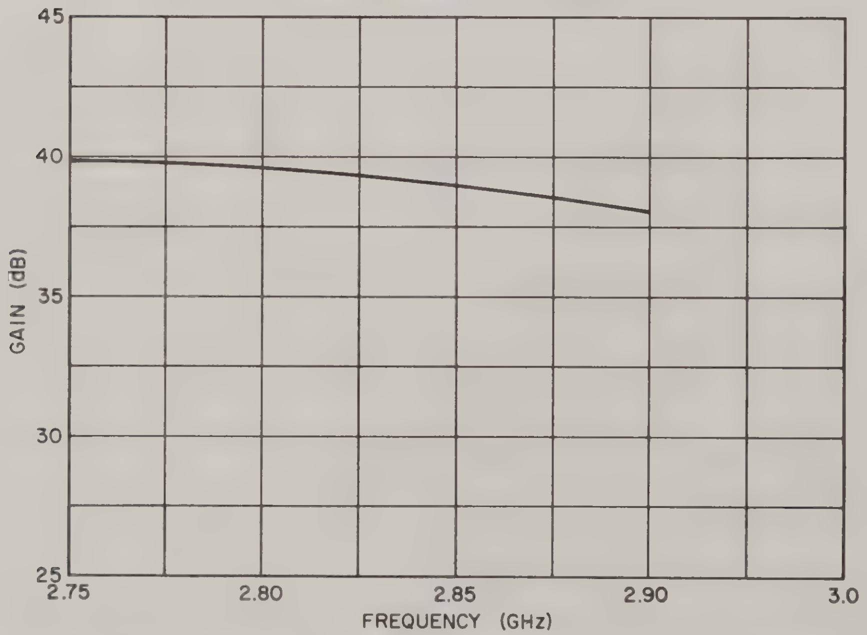
(See Footnotes on Page 2)

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

OUTPUT CHARACTERISTICS



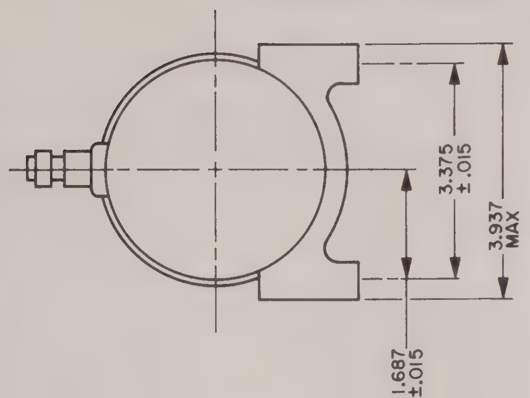
GAIN CHARACTERISTICS

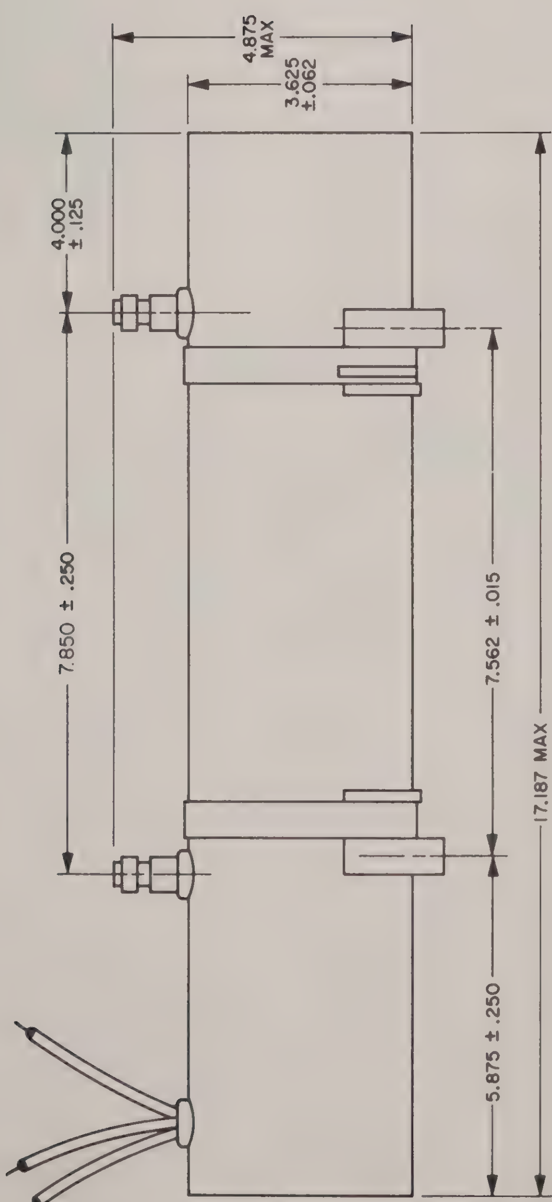


NOTES

1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.
3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.
4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range.
5. Voltage reference: grid to cathode.

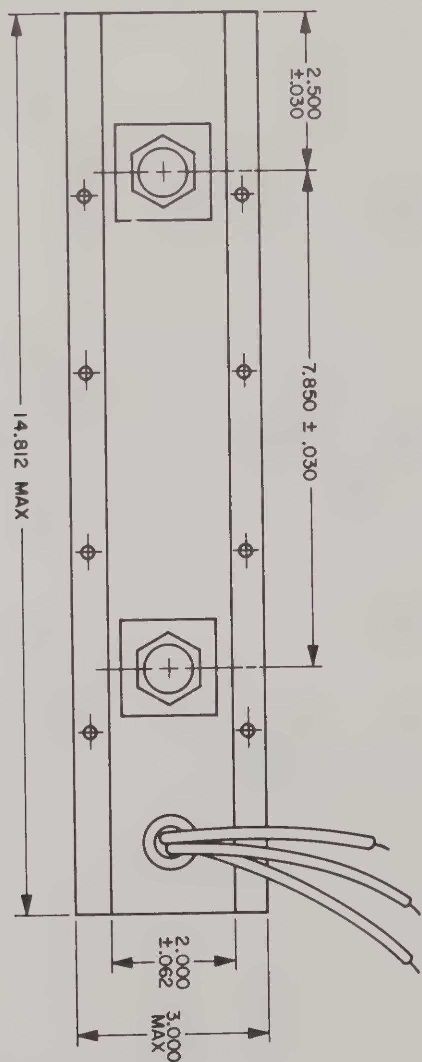
CONVECTION COOLED



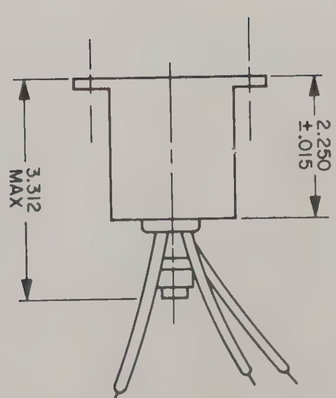


LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER CATHODE



EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

EM-118

PULSED
TRAVELING WAVE TUBE
2.0-4.0 GHz
100 W Peak

The EM118 is a grid modulated pulse TWT designed for use in airborne and missile environments. It delivers 100W peak saturation output power over the band 2.0-4.0 GHz. The EM118 is focussed by a periodic permanent magnet array and is compensated for operation at any temperature from -65°C to +125°C and can be supplied either conduction or forced air cooled.

MAXIMUM RATINGS[1]

Beam Voltage	4700V
Cathode Current	1.0A
Grid Bias Voltage	-300V
Duty Cycle	2%
Pulse Duration	100 μs
Heater Voltage	6.8V
Heater Surge Current	4.0A
Source VSWR	2.0 : 1
Load VSWR	2.5 : 1

GENERAL CHARACTERISTICS

ELECTRICAL

Frequency Range	2.0-4.0 GHz
Peak Output, (Min)	100W
Gain for 100W Output, (Min)	36 dB
Heater Voltage	6.3V
Heater Current, Typ	1.5A
Heater Warm-Up Time, (Min)	3.0 min
Grid Capacitance (To all other elements	40 pF
Grid Bias Voltage	-100V
Grid Drive Voltage[5]	+130V

PHYSICAL

Dimensions	See Outline
Weight, Approx	7.5 lb
Mounting Position	Any
RF Connectors	TNC

TYPICAL OPERATING CONDITIONS[2,3]

Output	See Curves
Gain	See Curves
Beam Voltage	4200V
Cathode Current, Peak	0.5A
Grid Bias Voltage	-100V
Grid Current, Peak	--
Duty	2%
Pulse Duration	80 μs
Load VSWR	2.0 : 1

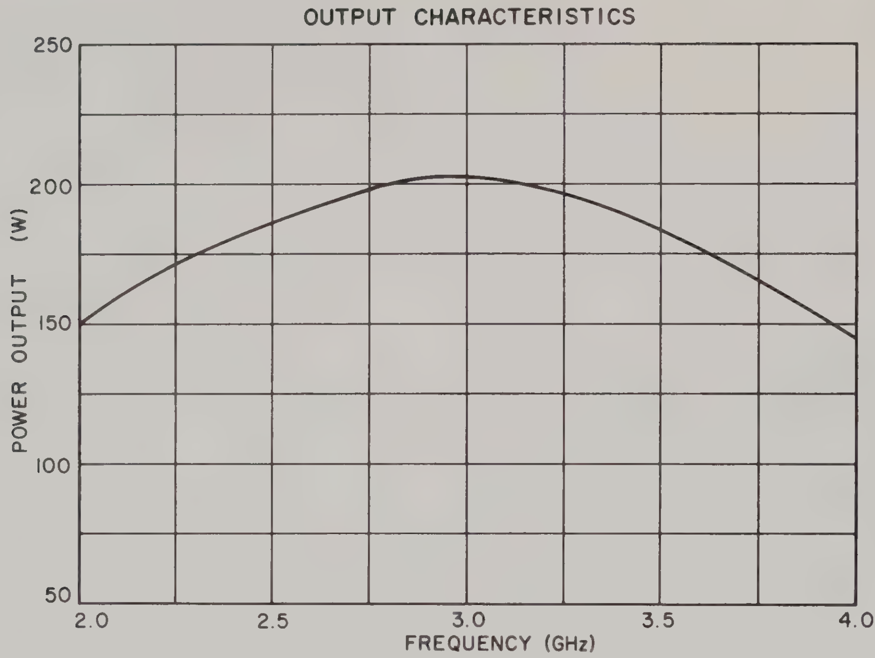
RANGE VALUES FOR EQUIPMENT DESIGN[2,4]

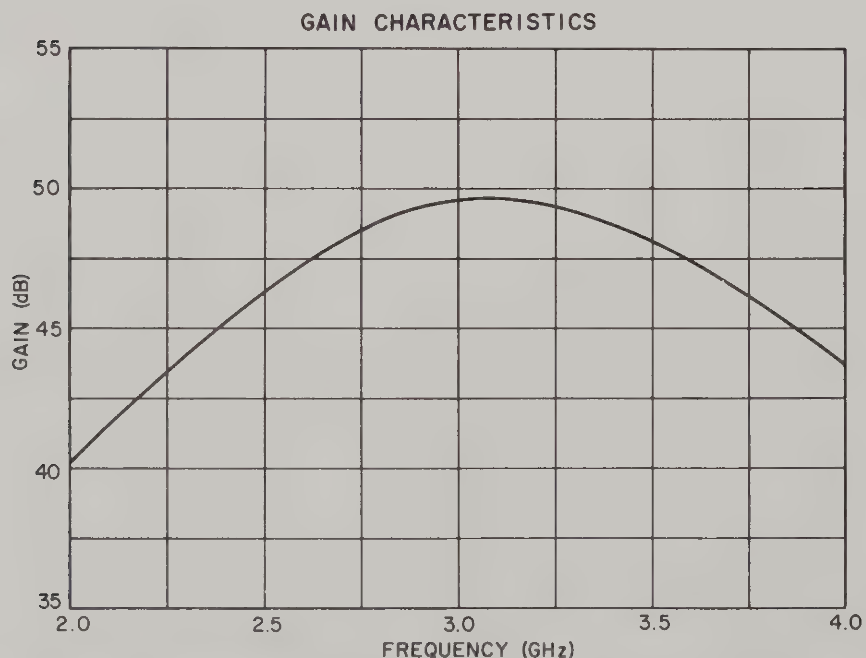
	Min.	*Max.*
Beam Voltage	4000	4700V
Cathode Current Peak	400	1000 mA
Grid Current	--	--
Heater Voltage	5.8	6.8V
Heater Current	1.0	1.8V
Grid Voltage	-60	-300V

(See Footnotes on Page 2)

NOTE: These data may be used for prototype design purposes. Before establishing production design specifications, contact the nearest Varian Sales Office or Microwave Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

Printed in U.S.A.





NOTES

1. Ratings should not be exceeded under continuous or transient conditions. Simultaneous operation at more than one rating may not be possible. Equipment design should limit voltage and environmental variations so that no rating will ever be exceeded.

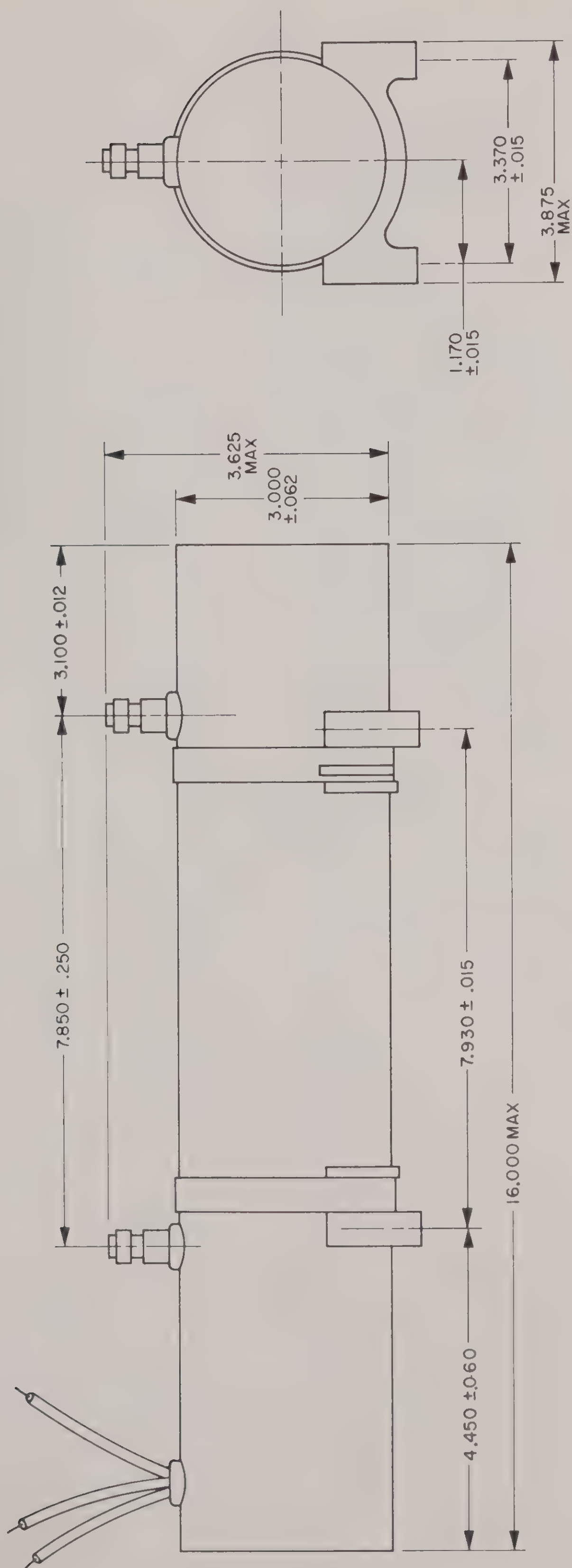
2. Characteristics and operating values are based on performance tests. These figures may change without notice with additional performance data or product refinement.

3. All voltages are referenced to the cathode. Gain and/or power output of the tube may be optimized at a slightly different voltage(s) depending on operating frequency.

4. These values are acceptance limits for the range of operating voltages that will optimize output power, gain, or bandwidth over the frequency range.

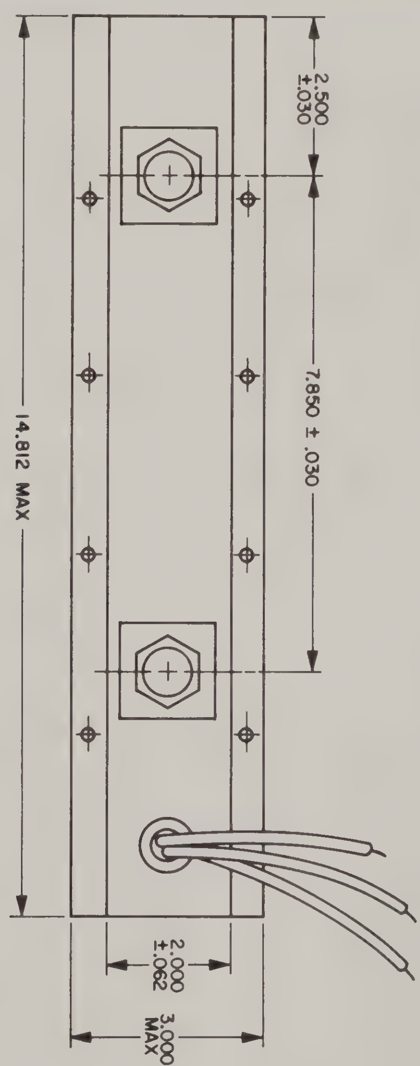
5. Voltage reference: grid to cathode.

CONVECTION COOLED

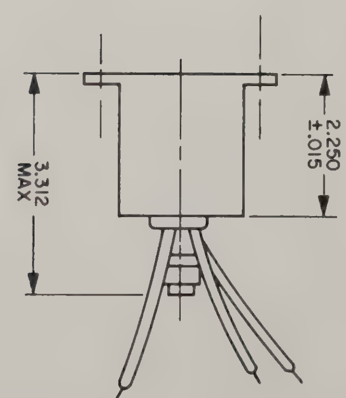


LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER CATHODE

CONDUCTION COOLED



LEAD	ELEMENT
GREEN	GRID
BROWN	HEATER
YELLOW	HEATER CATHODE



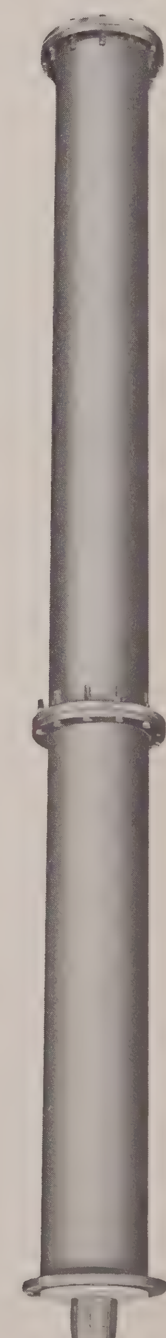
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TABLE OF CONTENTS
VOL. II

EITEL-McCULLOUGH, INC.

WL-150
WL-151
WL-160
WL-161
WATER LOADS
300 kW

200-750 Mc



Eimac WL-150, WL-151, WL-160, and WL-161 are $6\frac{1}{8}''$ coaxial water loads covering the frequency range of 200 to 750 megacycles. These loads will each dissipate up to 300 kilowatts average power. The WL-151 and WL-161 will also dissipate up to 5 megawatts peak power.

Water Loads WL-150 and WL-160 are equipped with sampling loops which provide convenient rf monitoring sources. Measurement of rf power by calorimetric methods* can be accomplished through the use of auxiliary temperature and flow measuring devices. Thermometer wells are available as accessories.

Because the rf power is dissipated directly into the fluid in these loads, the resistivity of the fluid affects the VSWR which the loads present. Fluids having specific resistances of 5000 ohm centimeters or less produce excellent results. Tap water and 50% to 60% solutions of ethylene glycol and distilled water are ordinarily acceptable. Because the resistivity of the fluid changes with temperature the outlet temperature should be kept as low as possible.

Water Loads WL-151 and WL-161 are equipped to withstand pressurization. The peak power ratings listed in this data sheet are with pressurization. If pressurization is employed provision must be made to prevent application of gas pressure without adequate fluid pressure. The gas pressure must not exceed the fluid pressure by more than 5 psi.

*Power dissipated in the load is determined calorimetrically as follows:

Power (kW) = K x Flow-rate (gpm) x Temperature Rise (°C).

For water, the constant (K) is 0.264.

Typical values of the constant (K) for a 60% ethylene glycol solution are: 0.208 at 15°C, 0.215 at 40°C, and 0.226 at 70°C.

CHARACTERISTICS

ELECTRICAL

	WL-150 WL-151	WL-160 WL-161
Frequency Range (Inlet Water Temperature 25°C, VSWR < 1.2:1)	250-750	200-750 megacycles
Frequency Range (Inlet Water Temperature 60°C, VSWR < 1.2:1)	390-750	340-750 megacycles
Average Power	300	300 kilowatts
Peak Power (WL-151 or WL-161, Pressurized)	5	5 megawatts
Impedance	50	50 ohms

Coupling (rf): EIA Standard RS-235

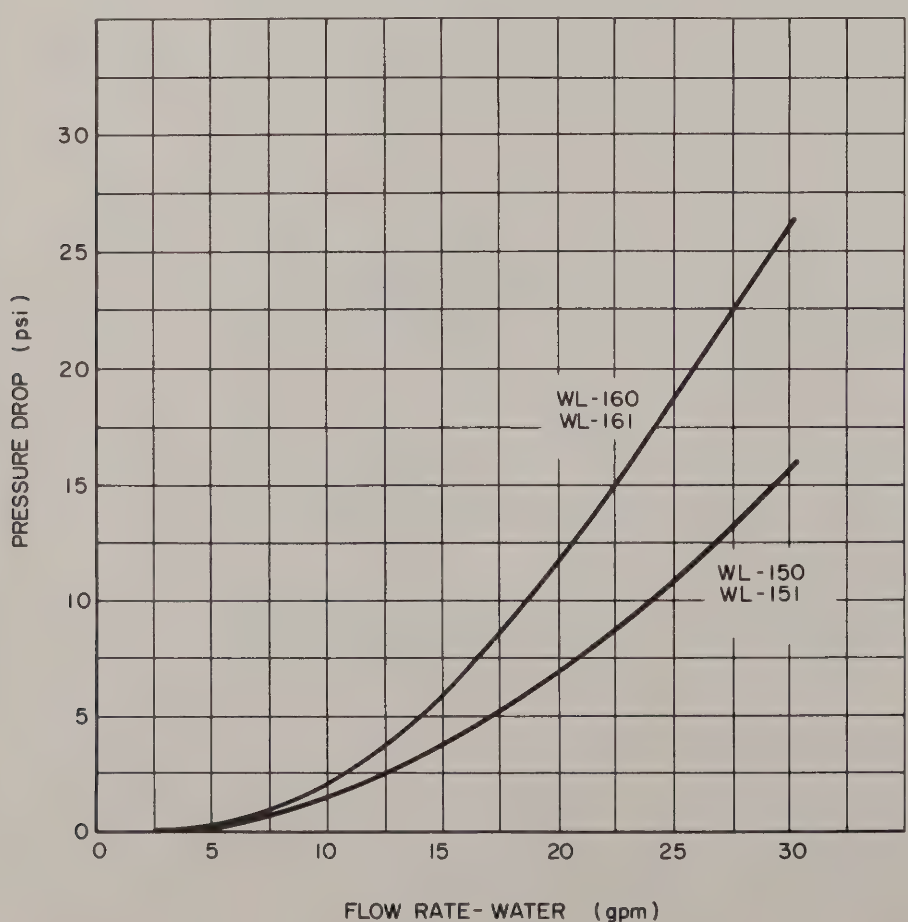
MECHANICAL

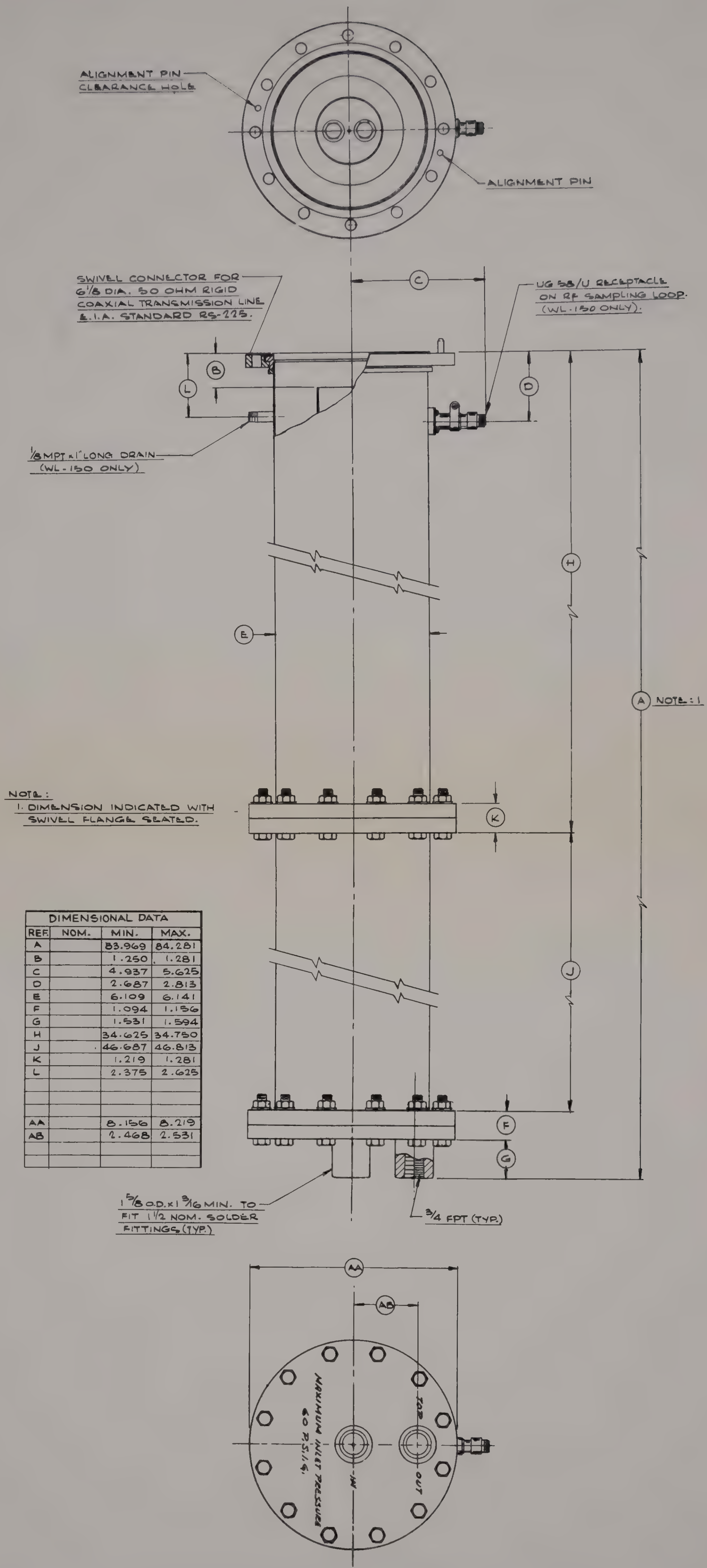
Operating Position: Horizontal or rf connection down

	WL-150 WL-151	WL-160 WL-161
Length	86.75	152.75 inches
Weight (Empty)	78	112 pounds
Water Capacity	7.5	17 gallons
Maximum Static Water Pressure	60	60 psig
Maximum Outlet Water Temperature	70	70 degrees C
Maximum Gas Pressure relative to water pressure	5	5 psi

Water Connections: ¾" F.P.T.

For additional information or information regarding a specific application, write to Eitel-McCullough, San Carlos, California

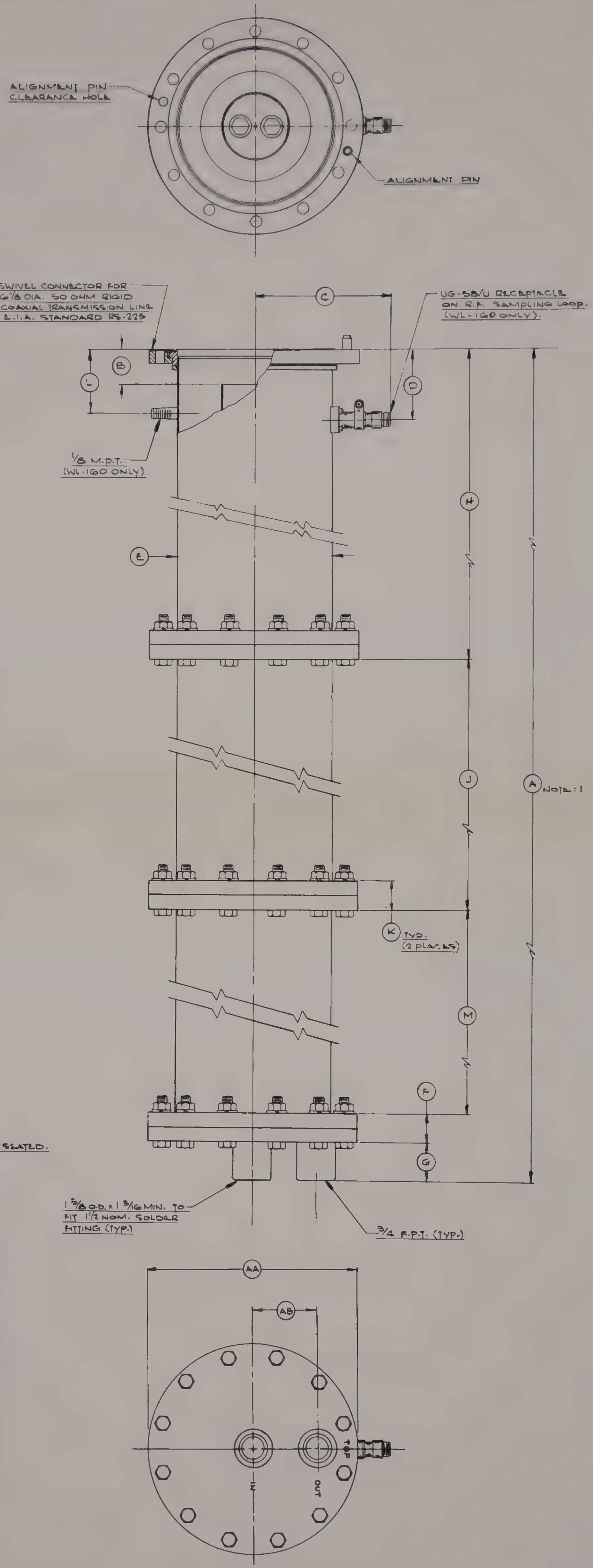




DIMENSIONAL DATA

REF.	NOM.	MIN.	MAX.
A		83.969	84.281
B		1.250	1.281
C		4.937	5.625
D		2.687	2.813
E		6.109	6.141
F		1.094	1.156
G		1.531	1.594
H		34.625	34.750
J		46.687	46.813
K		1.219	1.281
L		2.375	2.625
AA		8.156	8.219
AB		2.468	2.531

WL-150, WL-151 OUTLINE



NOTE:
1. DIMENSION INDICATED WITH SWIVEL FLANGE SEATED.

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A		149.906	150.282
B		1.250	1.280
C		4.937	5.625
D		2.687	2.813
E		6.109	6.141
F		1.094	1.156
G		1.531	1.594
H		34.625	34.750
J		47.937	48.063
K		1.219	1.281
L		2.375	2.625
M		64.687	64.813
AA		8.156	8.219
AB		2.468	2.531

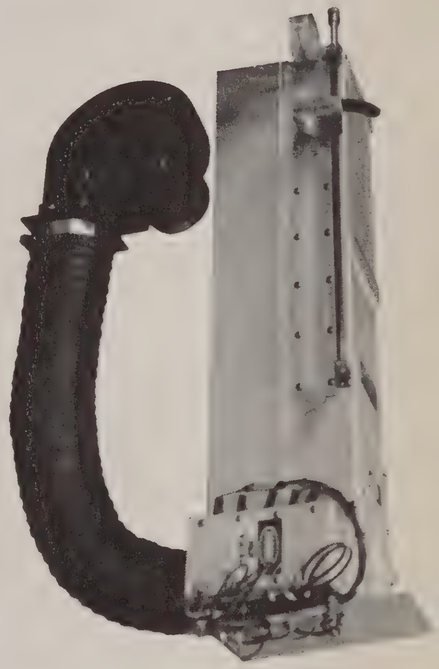
WL-160, WL-161 OUTLINE

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4505
CAVITY AMPLIFIER
122-150 Mc

The Eimac EM4505 is a cavity amplifier incorporating the Eimac 4CX250R ruggedized ceramic tetrode. It is designed for use as an intermediate stage in an FM transmitter. Tuning controls are provided.



CHARACTERISTICS

ELECTRICAL

Frequency, continuously tunable		122-150 Mc
RF Power Output		30 watts* CW
RF Drive Power Required		1W*
Power Supply Requirements (Typical):	Voltage	Current
Anode, maximum	400 to 800 V*	150-250 mA*
Screen Grid, maximum	80 to 175 V	±25 mA
Control Grid, maximum	—35 to —60 V	±25 mA
Heater	6.0 V	2.6 A
Tube Type		Eimac 4CX250R
Load Impedance		50 ohms
Bandwidth		2 Mc minimum at 1.5 db
Modulation		FM

MECHANICAL

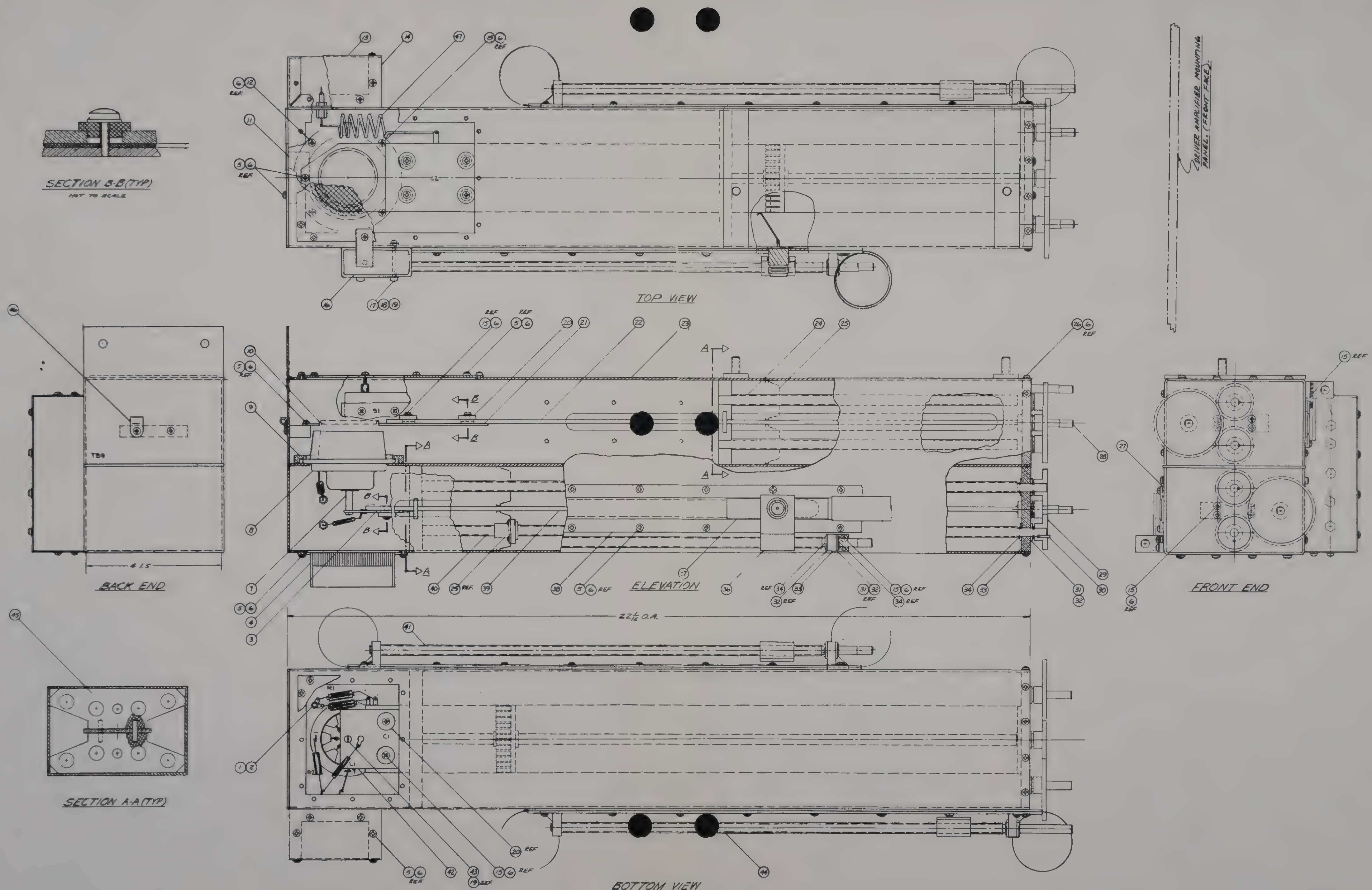
Mounting	Standard 19" relay rack Panel
Size	height — 13 inches width — 8½ inches depth — 26 inches
Operating controls	Tuning knobs provided
Cooling required	Blower included
Connectors	Type N Female

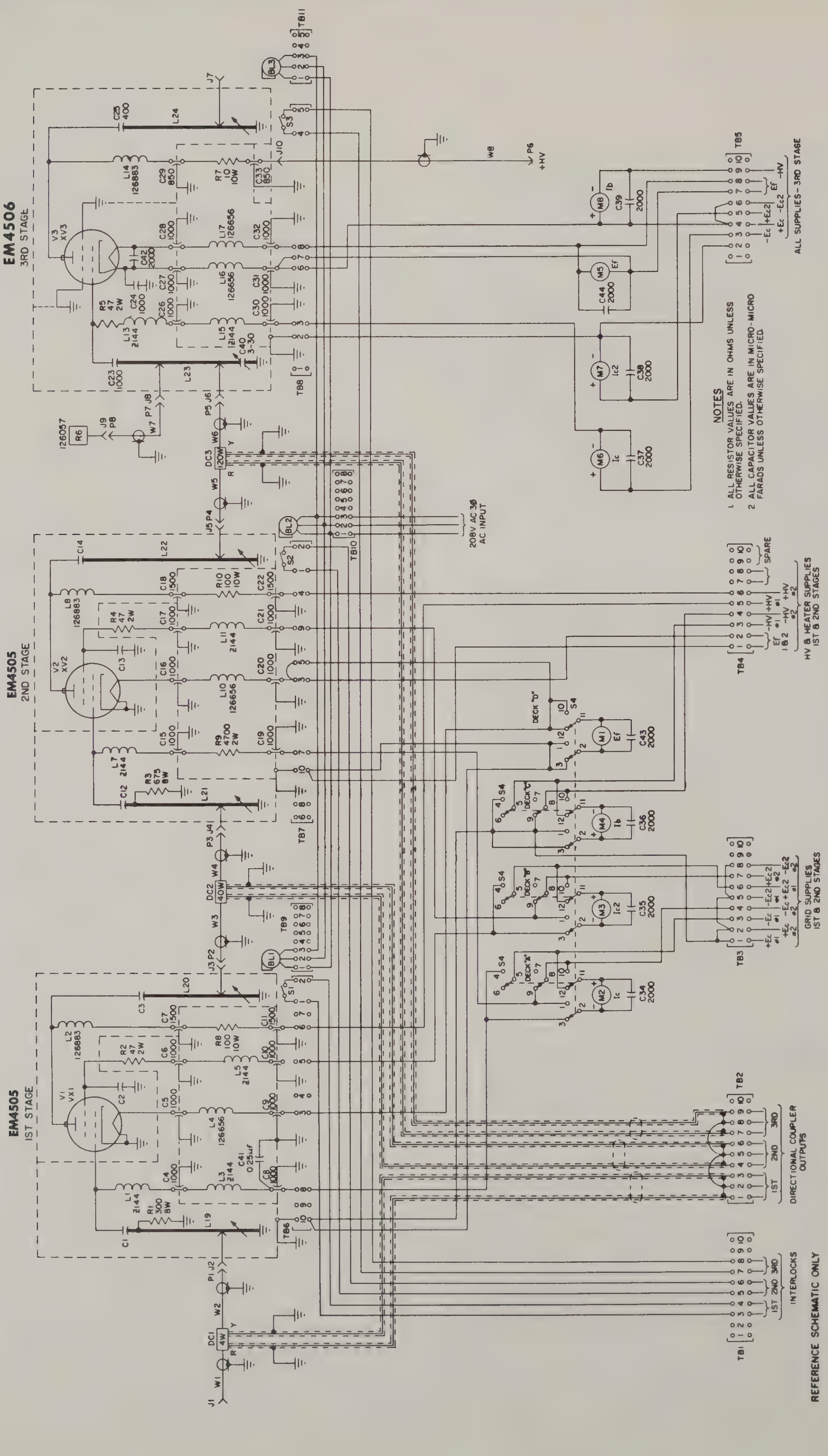
ENVIRONMENTAL

Temperature	—10 to +50°C (+14 to +122°F)
Altitude	to 12,000 feet

*Up to 200 watts output can be provided with higher anode voltage and drive.

EM4505


SECTION B-B (TYP)
NOT TO SCALE
TOP VIEW
DRIVER AMPLIFIER MOUNTING PANEL. (FRONT FACE)
BACK END
ELEVATION
FRONT END
22½ O.A.
SECTION A-A (TYP)
BOTTOM VIEW


EM4505
1ST STAGE
EM4505
2ND STAGE
EM4506
3RD STAGE
208V AC 3Ø
AC INPUT
NOTES
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES ARE IN MICRO-MICRO FARADS UNLESS OTHERWISE SPECIFIED.
ALL SUPPLIES-3RD STAGE
HV & HEATER SUPPLIES 1ST & 2ND STAGES
SPARE
GRID SUPPLIES 1ST & 2ND STAGES
DIRECTIONAL COUPLER OUTPUTS
INTERLOCKS
REFERENCE SCHEMATIC ONLY

Eimac®

EITEL-McCULLOUGH, INC.

Tentative Data

EM4534
TELEMETRY TRANSMITTER

1435 - 1535 Mc
3 Watts

Eitel-McCullough L-Band transmitters provide over 3 watts rf output with over 13% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. They are designed to operate during the severe shock and vibration of missile launch.

Model EM4534 is a complete transmitter, including a pre-regulated DC-DC converter. All circuits are solid state, except the rf power oscillator, which is a single stage rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter is packaged in less than 50 cubic inches, and weighs less than 4.5 pounds. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 1435-1535 Mc band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range —40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 Mc is accomplished at ±2.5% linearity, and ±300Kc at ±0.5% linearity.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	1435-1535 Mc
Power Output, CW Minimum	3 Watts
Frequency Accuracy	±0.001%
Frequency Stability	±0.001%
Carrier Deviation, Adjustable, peak-to-peak	2Mc/Volt to 30Kc/Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 cps to 500 Kc
Flat within ±1 db	5 cps to 800 Kc
Modulation Linearity, Deviation from B.S.L.,	
For ±300 Kc peak Deviation	±0.5%
For ±1.5 Mc peak deviation	±2.5%
Incidental Frequency Modulation, Maximum	3.5 Kc rms
AM, Maximum, due to environmental conditions	1%
due to ±300 Kc carrier deviation	1%
due to ±1.5 Mc carrier deviation	5%
Modulation Input Impedance, Minimum, 5 cps to 800 Kc	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	825 mA
Primary Ripple, maximum, peak-to-peak from Dc to 20 Kc	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
VSWR Maximum, any phase, for 2 watts output	1.5:1
for 1 watt output	5.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	500 hours

PACKAGING

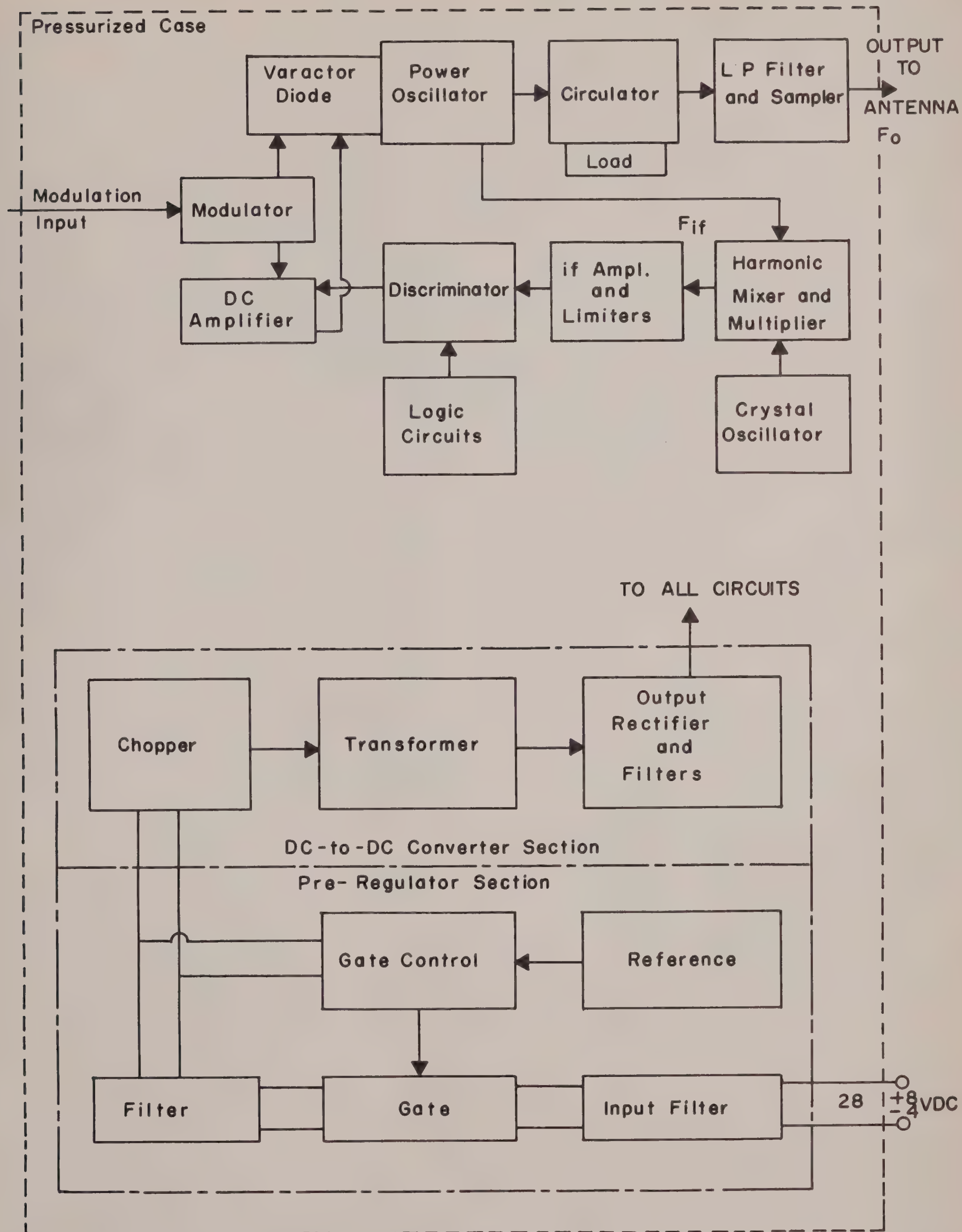
Volume displaced	48 cubic inches
Dimensions, including mounting flanges	6.5" x 4.4" x 1.9"
Weight	4.5 pounds
Pressurization (will maintain within 75% for 1 year)	30 psia
Cooling	Conduction to heat sink

ENVIRONMENTAL SPECIFICATIONS[3]

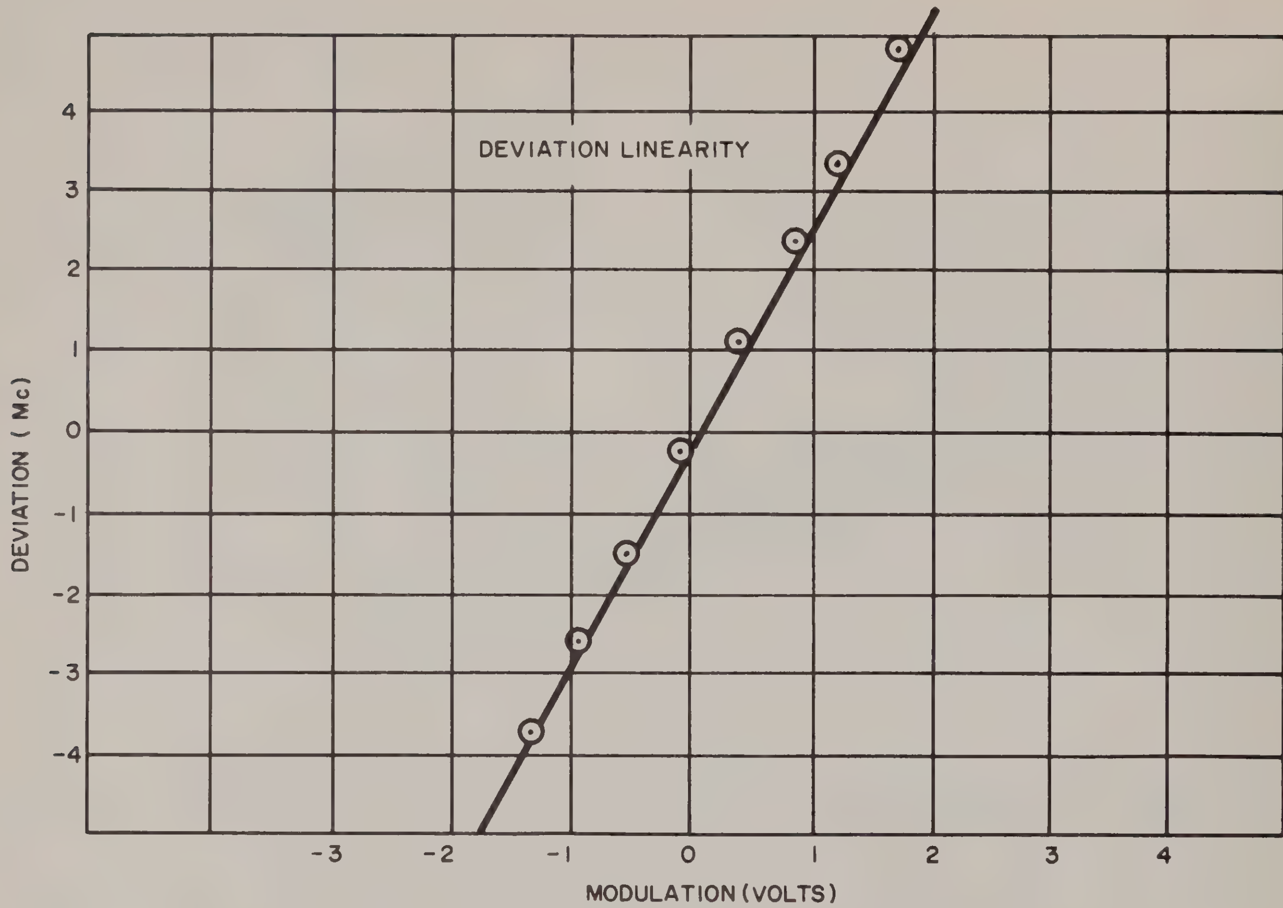
Temperature[4] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration (MIL-STD-810, Figure 514-3 Curve D)	15G peak to 2 Kc
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/cps
Air Induced Vibration	150 db above $2x10^{-4}/CM^2$ from 150 to 2000 cps, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration	30G for 5 minutes, three axes
Shock, per MIL-STD-810 Method 516, Procedures I and V,	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[5]	100G

[5]Out-of-tolerance operation may occur during 100G shock.
[4]Other ranges available on special order.
[3]Transmitter performs as specified, under any combination of environmental conditions.

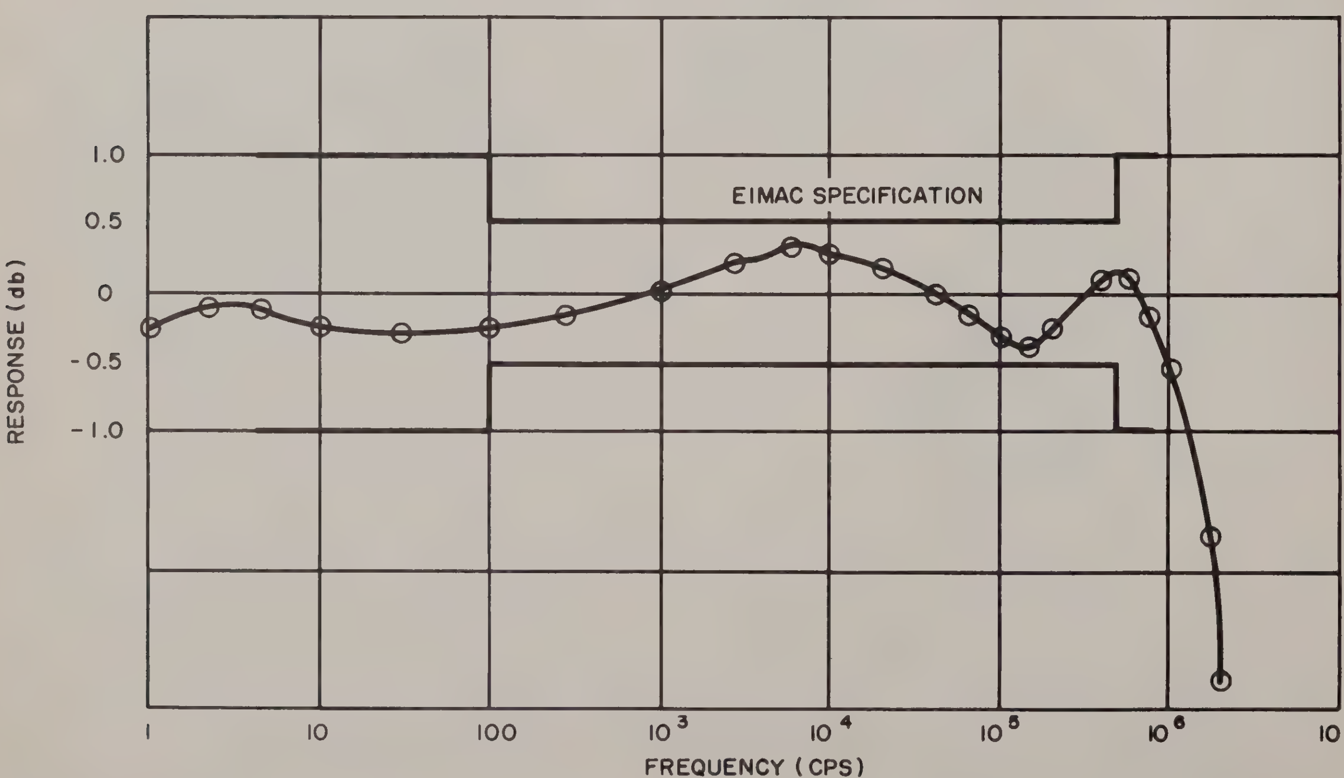
[2]Under emergency conditions, full rf output is provided with primary power as low as 20 Vdc, but increased IFM and AM will occur.
[1]Also available modified for modulation down to DC.



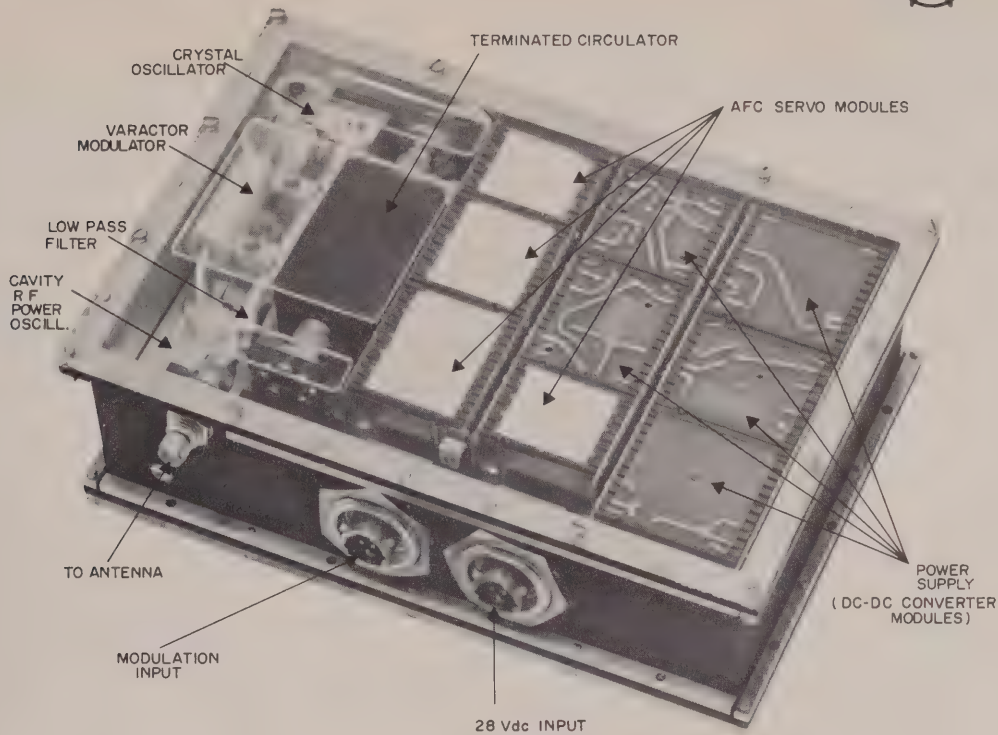
BLOCK DIAGRAM
MODEL EM4534 3W L-BAND TELEMETRY TRANSMITTER



DEVIATION LINEARITY OF EM4534 TRANSMITTER

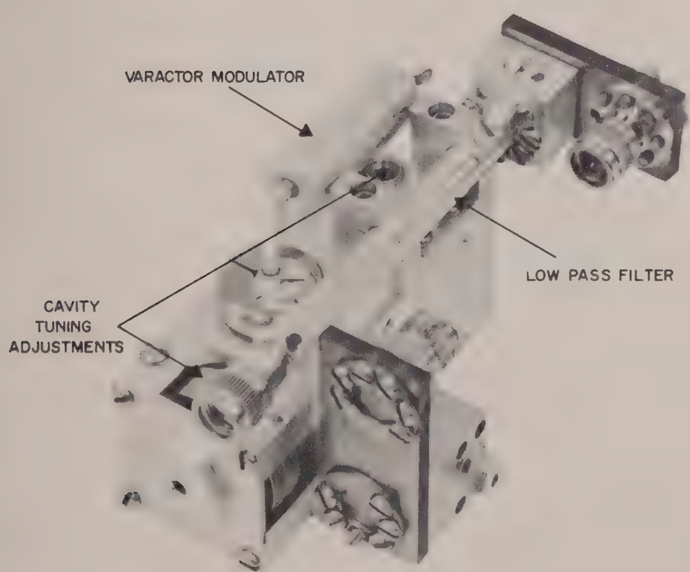


MODULATION FREQUENCY RESPONSE OF EM4534 TRANSMITTER



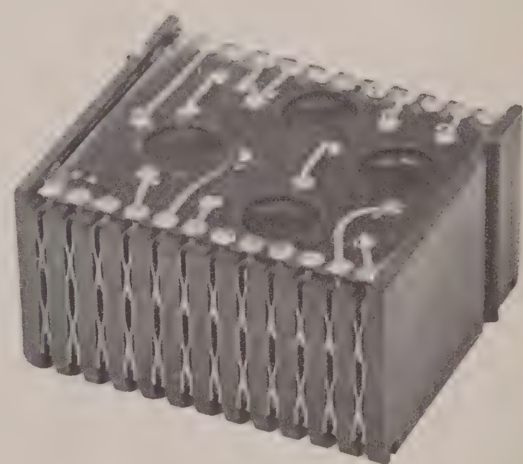
EM4534 TELEMETRY TRANSMITTER ASSEMBLY

Packaging of this transmitter is compact, yet all modules are easily accessible by removing top and bottom covers. The covers incorporate pressure seals and rfi gaskets.



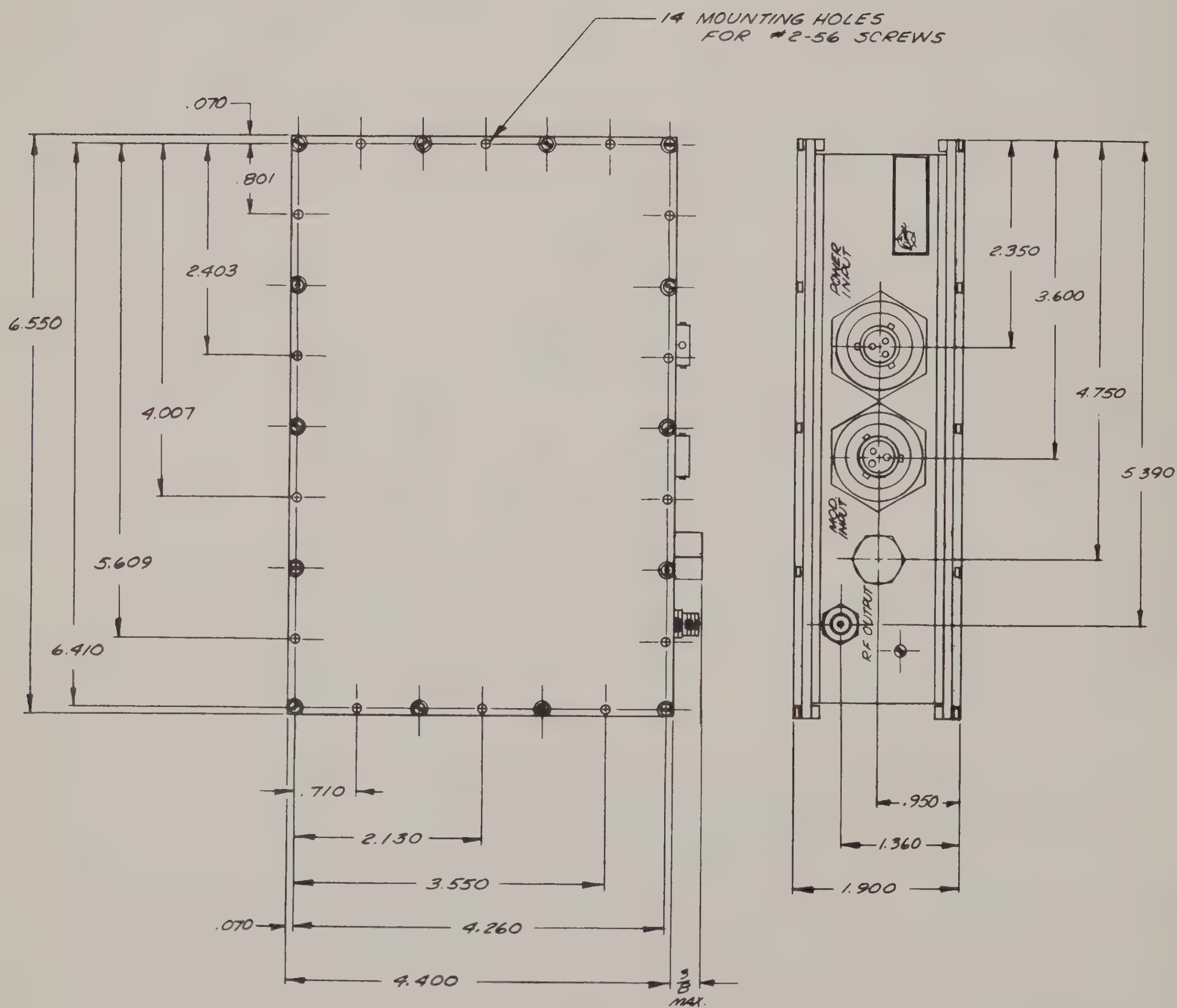
RF SECTION, EM4534 TRANSMITTER

The rf power oscillator provides over 3 watts, tunable 1435-1535 Mc. There is no output below 1435 Mc. Harmonics are removed by a low pass filter. The ceramic planar triode in the oscillator is conduction cooled to the transmitter case.



TYPICAL PLUG-IN MODULE

Circuits use only high reliability components such as silicon planar transistors and are packaged in modular form. The modules are easily removable, and offer flexibility for future modification. The connector system provides four redundant contacts at each connection. All modules are encapsulated with a rigid high thermal conductivity compound for heat conduction and vibration protection.


14 MOUNTING HOLES
FOR #2-56 SCREWS
.070
.801
2.403
6.550
4.007
5.609
6.410
.710
2.130
3.550
.070
4.260
4.400
3/8
MAX.
POWER INPUT
MOD INPUT
RF OUTPUT
2.350
3.600
4.750
5.390
.950
1.360
1.900

EITEL-McCULLOUGH, INC.

TABLE OF CONTENTS

VOL. II

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

Tentative Data

EM4567
TELEMETRY TRANSMITTER

2200 - 2300 Mc
8 Watts

This Eitel-McCullough S-Band transmitter provides over 8 watts rf output with over 15% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. It is designed to operate during the severe shock and vibration of missile launch.

Model EM4567 is a complete transmitter, including a pre-regulated DC-DC converter. All circuits are solid state, except the rf power oscillator, which is a single stage rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter is packaged in less than 110 cubic inches, and weighs less than 8 pounds. Modulation is true FM. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 2.2-2.3 Gc band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range —40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 Mc is accomplished at ±2.5% linearity, and ±300Kc at ±0.5% linearity.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	2200-2300 Mc
Power Output, CW Minimum[7]	8 Watts
Frequency Accuracy	±0.001%
Frequency Stability[8]	±0.0025%
Carrier Deviation, Adjustable, peak-to-peak	2Mc/Volt to 30Kc/Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 cps to 500 Kc
Flat within ±1 db	5 cps to 800 Kc
Modulation Linearity, Deviation from B.S.L.,	
For ±300 Kc peak Deviation	±0.5%
For ±1.5 Mc peak deviation	±2.5%
Incidental Frequency Modulation, Maximum	3.5 Kc rms
AM, Maximum, due to environmental conditions	1%
due to ±300 Kc carrier deviation	1%
due to ±1.5 Mc carrier deviation	5%
Modulation Input Impedance, Minimum, 5 cps to 800 Kc	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	1.9A
Primary Ripple, maximum, peak-to-peak from Dc to 20 Kc	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
Input current rise above nominal, due to fault[3], maximum	30%
VSWR Maximum, any phase, for 8 watts output[7]	1.5:1
for 4 watt output	5.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	200 hours

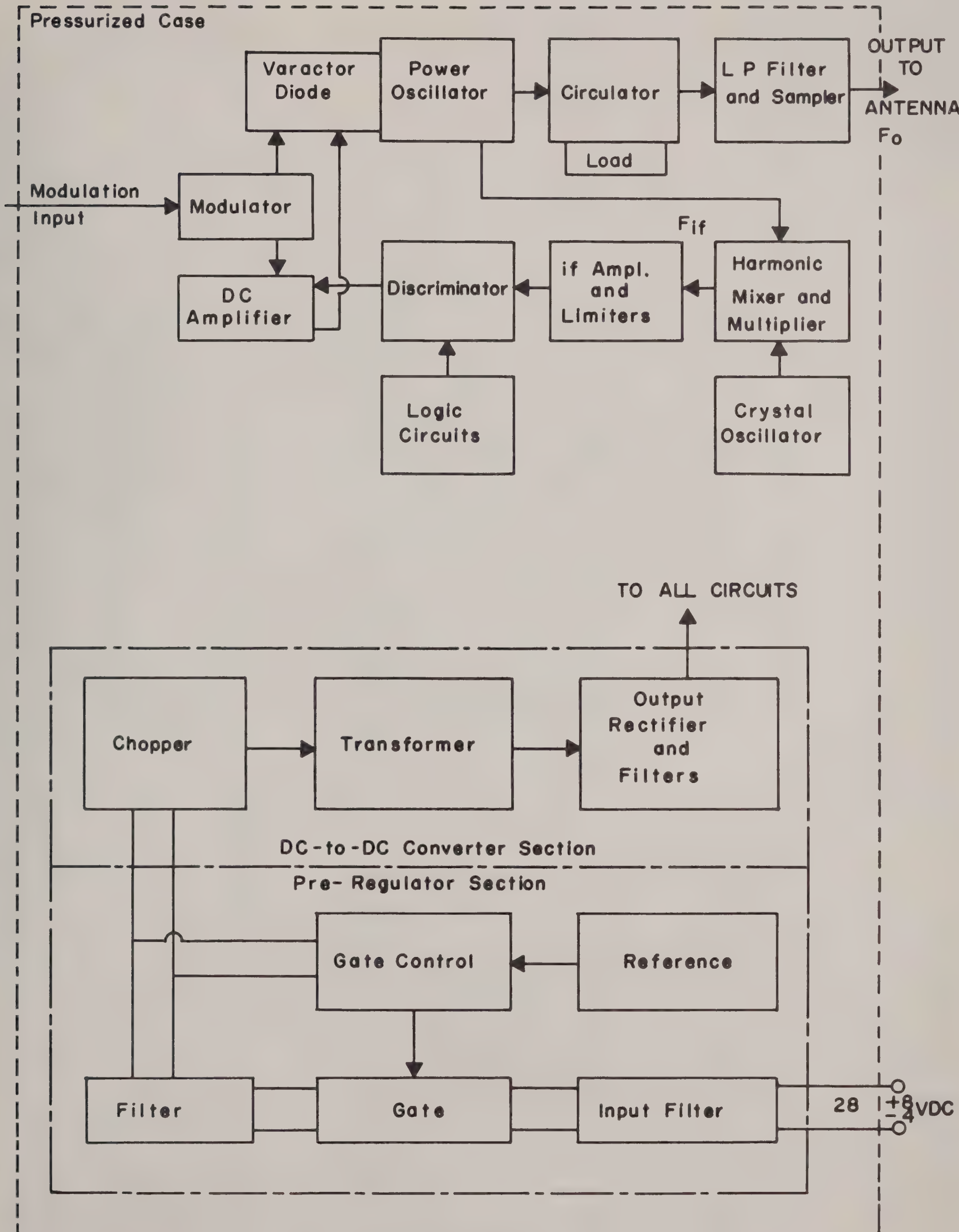
PACKAGING

Volume displaced	98 cubic inches
Dimensions, including mounting flanges	8" x 5.5" x 2.5"
Weight	8 pounds
Pressurization	30 psia
Cooling	Conduction to heat sink
Connectors, rf	TNC Female
Power and Modulation	Bendix PTO7 Male

ENVIRONMENTAL SPECIFICATIONS[4]

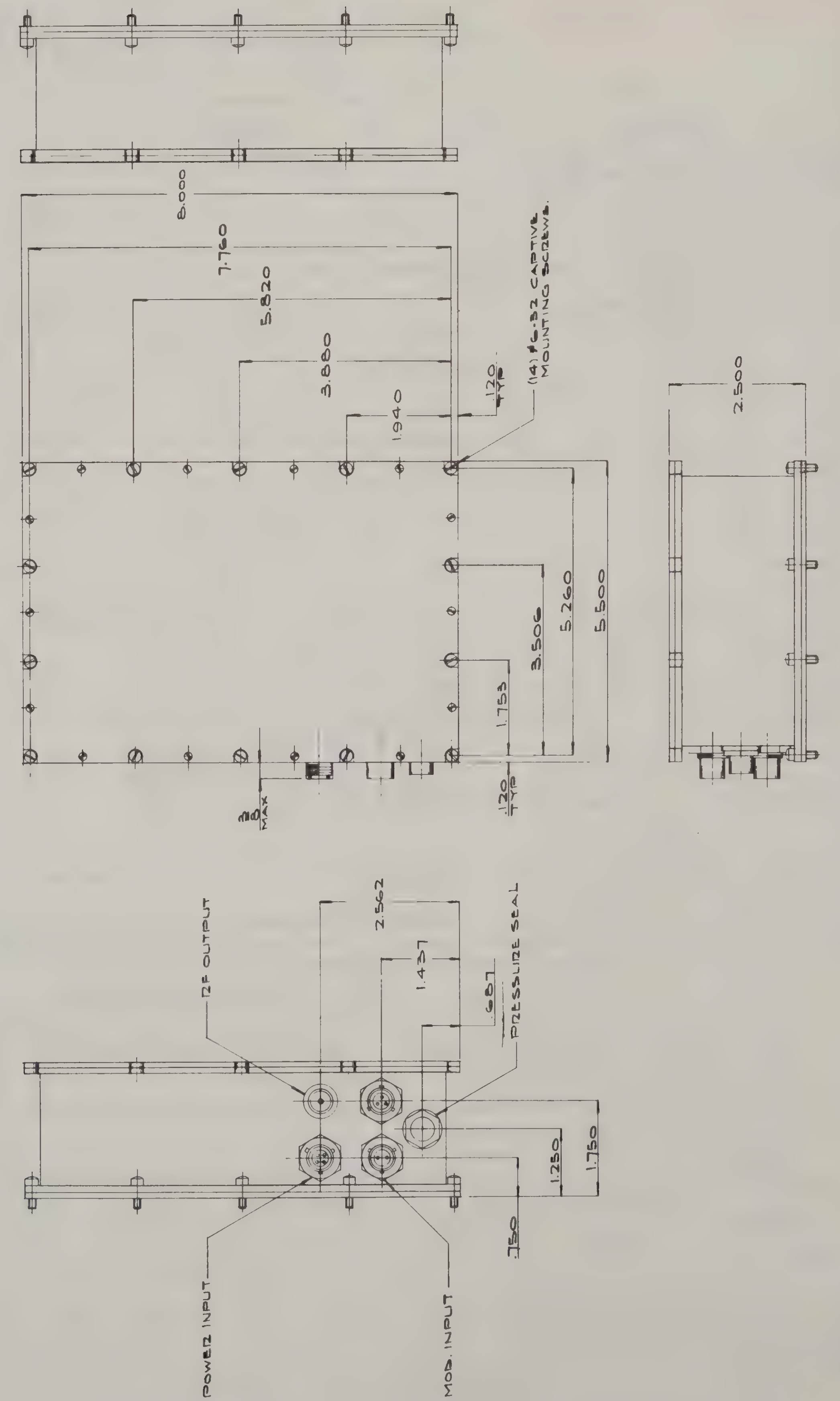
Temperature[5] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration[9] (MIL-STD-180, Figure 514-3 Curve D)	15G peak to 2 Kc
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/cps
Air Induced Vibration	150 db above $2x10^{-4}/CM^2$ from 150 to 2000 cps, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration[9]	30G for 5 minutes, three axes
Shock[9], per MIL-STD-810 Method 516, Procedures I and V,	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[6]	100G

[9] Available for use in more severe environment, on special order.
[8] Stability of ±0.001% from —40°C to +85°C is available on special order.
[7] Over temperature range of —20°C to +70°C. Minimum power output for —40°C to +85°C is 6 watts.
[6] Out-of-tolerance operation may occur during 100G shock.
[5] Other ranges available on special order.
[4] Transmitter performs as specified, under any combination of environmental conditions.
[3] Any failure of transmitter (except at input terminals).
[2] Under emergency conditions, full rf output is provided with primary power as low as 20 Vdc, but increased IFM and AM will occur.
[1] Also available modified for modulation down to DC.



BLOCK DIAGRAM

EM4567 8 Watt 2200-2300 Mc TELEMETRY TRANSMITTER


8.000
7.760
5.820
3.880
1.940
.120 TYP
(14) #6-32 CAPTIVE MOUNTING SCREWS
2.500
5.500
5.260
3.506
1.753
.120 TYP
MAX
2.562
1.437
.687
PRESSURE SEAL
RF OUTPUT
1.750
1.250
.750
POWER INPUT
MOD. INPUT

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

TABLE OF CONTENTS

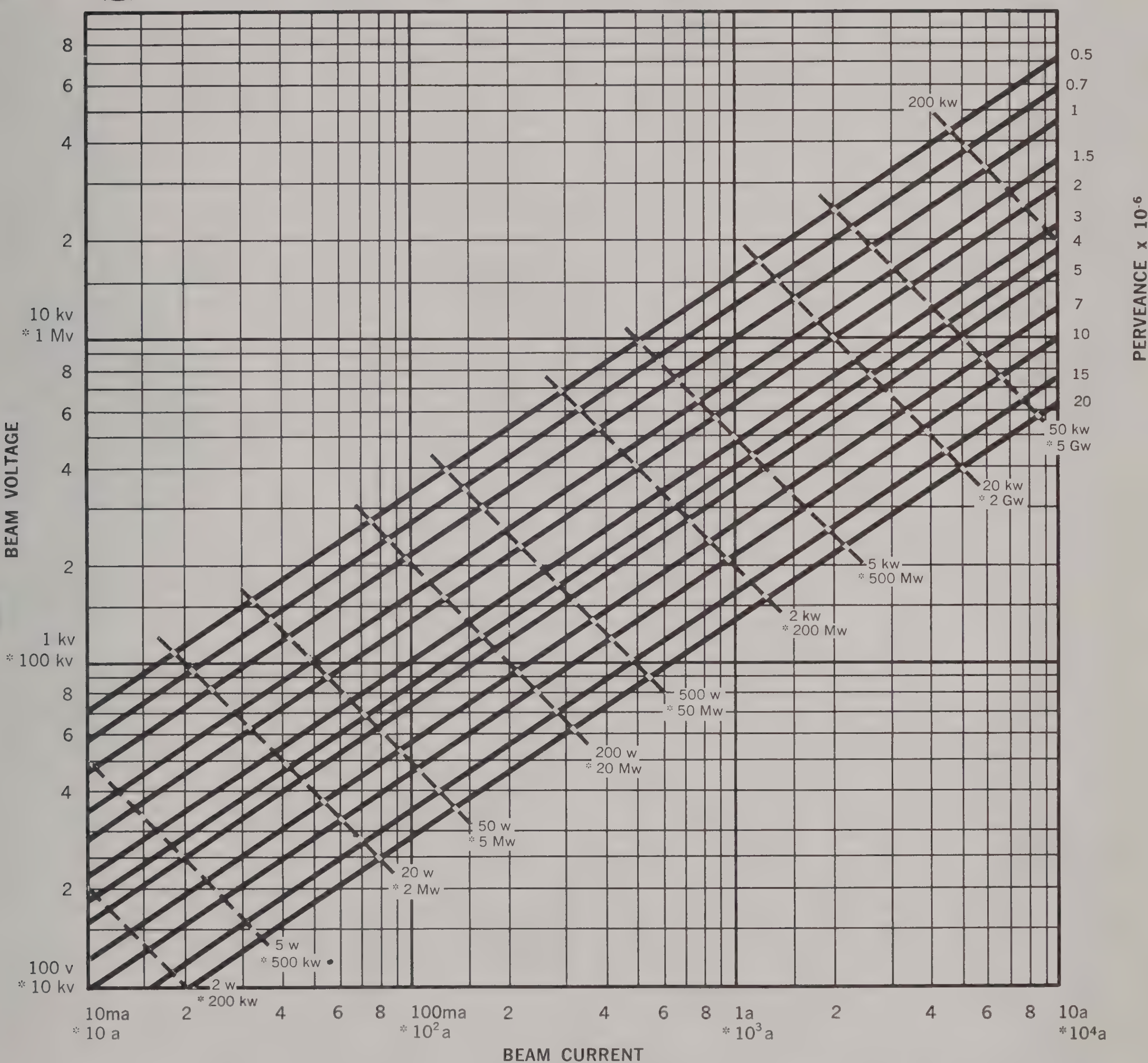
VOL. II

* Divider Sheets Not Available

Effective Date 4-30-65

4/12/65
[redacted]

EIMAC BEAM CALCULATOR



CONSTANT BEAM POWER LINES (dashed)

CONSTANT PERVEANCE LINES (solid)

* NUMBERS PERTAINING TO HIGHER SCALE

Eimac®

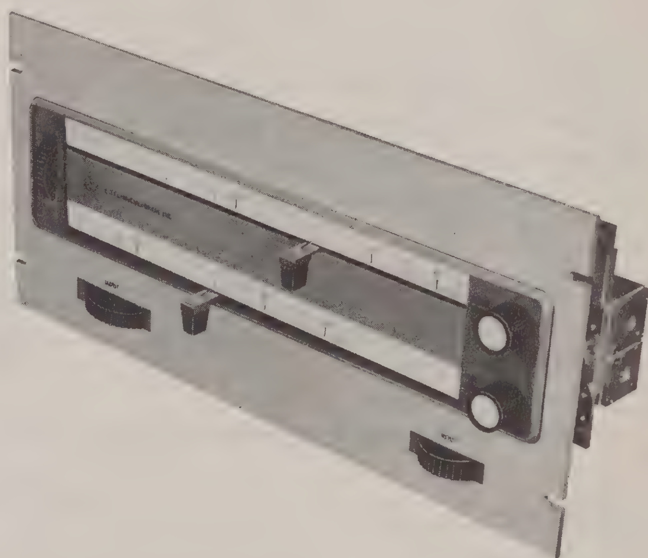
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

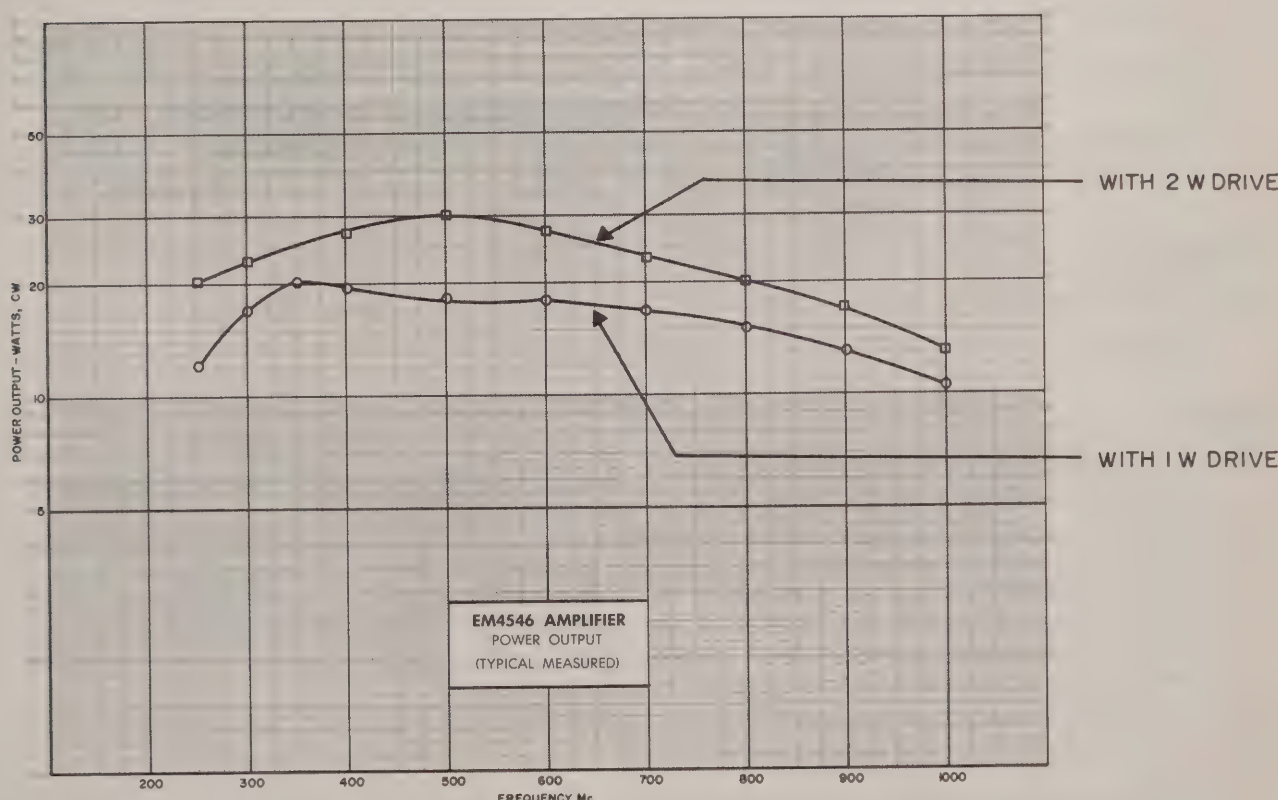
EM4546

BROAD TUNING AMPLIFIER

250-1000 Mc

The Eimac EM4546 is a broad-tuning cavity power amplifier incorporating the Eimac Y-319 ceramic-metal planar triode. It is intended for use in test equipment consoles and special transmitters. This Amplifier has front-panel tuning knobs and frequency scales for tuning across the 250-1000 Mc band. Power output is 20 to 10 watts with 1 watt rf drive and 30 to 10 watts with 2 watts rf drive.





CHARACTERISTICS

ELECTRICAL

Frequency, continuously tunable		250-1000 Mc
RF Power Output, minimum (1 watt drive)	Frequency, Mc	Power output, watts, CW
	250- 300	10
	300- 800	15
	800-1000	10
Gain (with 1 watt drive), minimum		10 db
Frequency Drift,[1] percent of operating frequency		±0.05%
Power Supply Requirements:	Voltage	Current
Anode, maximum	1 KV	100 mA
Grid	Bias through variable cathode resistor, 200-1000 ohms	
Heater	6.0 v	1A
Cathode Current		125 mA
Tube Type		Eimac Y-319
Load Impedance		50 ohms nominal
Load VSWR, maximum		2.0:1 any phase, without damage

MECHANICAL

Mounting	Standard 19" relay rack
Size	height — 8¾ inches depth — 4½ inches
Weight	10 pounds
Operating Controls	Tuning knobs and frequency scales provided[2]
Cooling	Conduction — Convection[3]
Connectors	Type TNC Female

ENVIRONMENTAL

Temperature	—10 to +50°C (+14 to +122°F)[3]
Altitude	to 12,000 feet

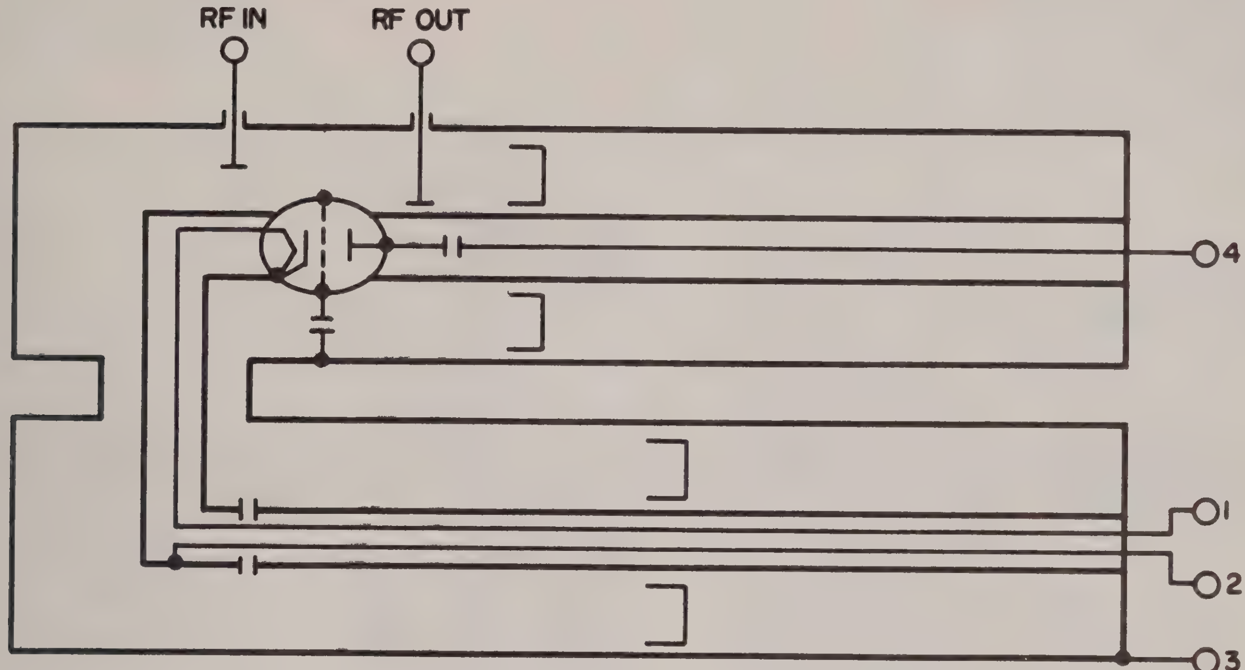
NOTES:

(1) Frequency drift is specified over a period of 2 hours, following a warm-up period of ½ hour minimum.

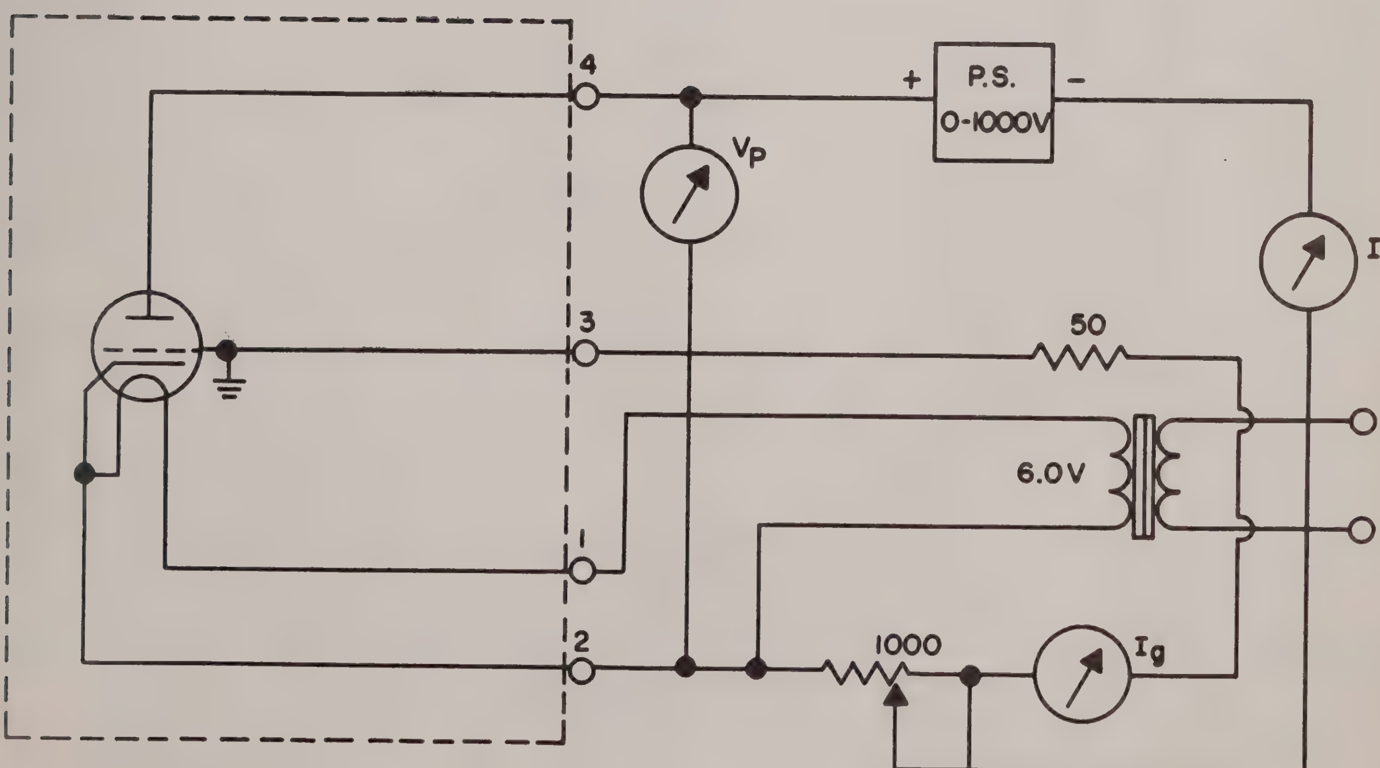
(2) Knobs are provided on the front panel for fine tuning the plate and cathode cavities and for adjusting input and output coupling. Frequency scales are provided for each cavity. Tuning is accomplished by sliding the pointers to the desired frequency, then adjusting the fine tuning and coupling. Access to the interior of the amplifier is not required for tuning. Four sets of scales are provided, covering four sections of the tuning range. The desired set of scales is selectable by a knob on the front panel.

(3) If ambient temperature exceeds 90°F, the cavity body will become quite hot (up to 250°F), and forced air cooling is recommended.

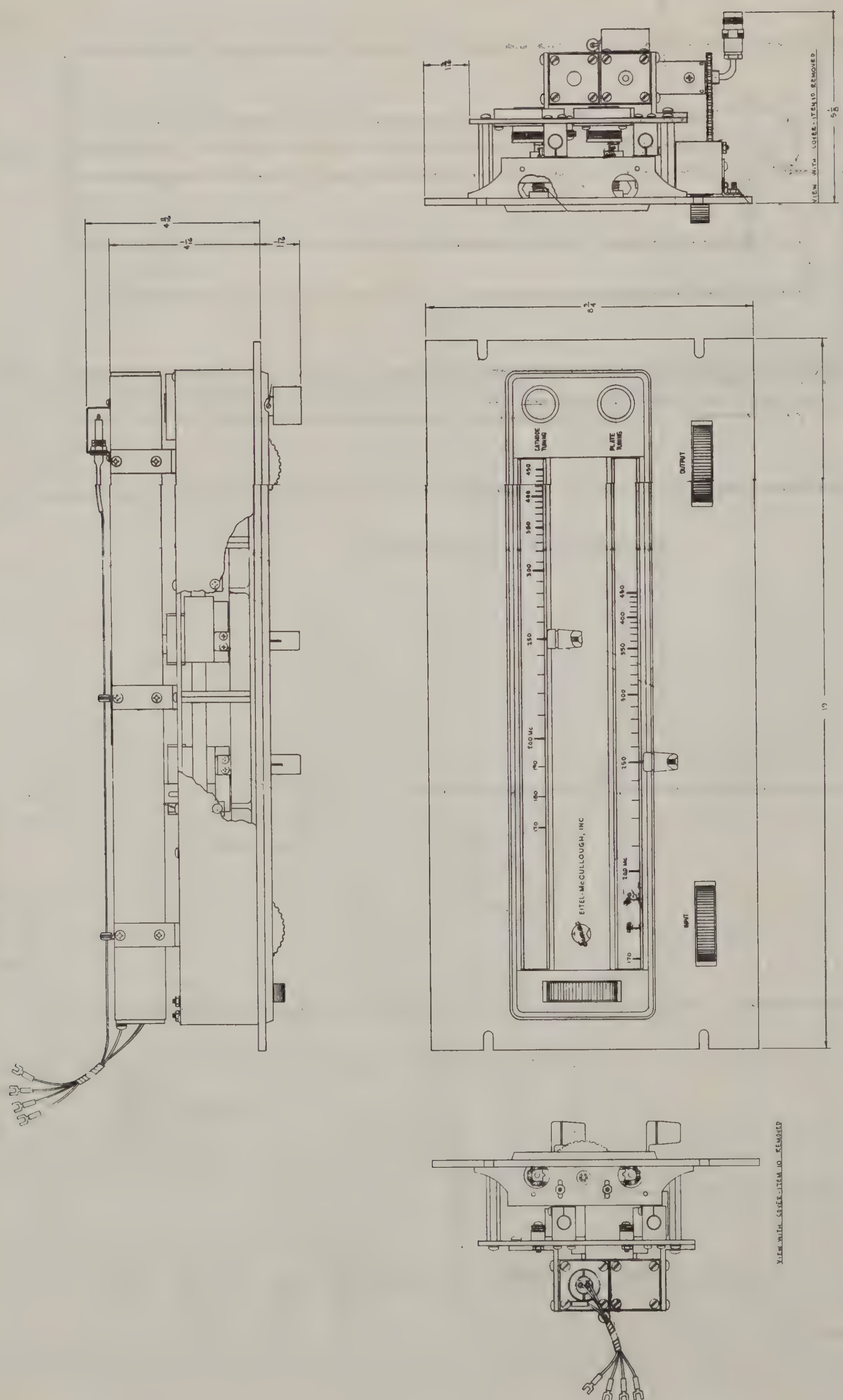
For personnel protection, high voltage circuits above 500 volts are enclosed and identified. Interlocks are not provided.



EM4546 CAVITY AMPLIFIER



EM4546 POWER SUPPLY CONNECTIONS

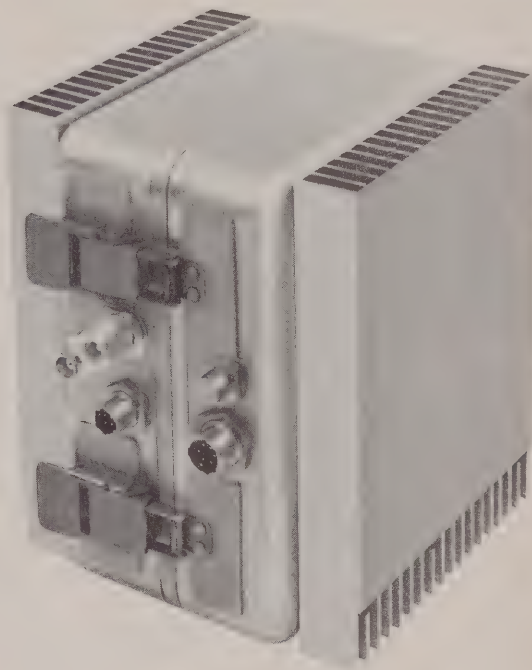

VIEW WITH COVER-ITEM 10 REMOVED
CATHODE TUNING
PLATE TUNING
OUTPUT
INPUT
EITEL-McCULLOUGH, INC
VIEW WITH COVER-ITEM 10 REMOVED

EITEL-McCULLOUGH, INC.

Tentative Data

EM4575
TELEMETRY TRANSMITTER

2200 - 2300 Mc
4 Watts



This Eitel-McCullough S-Band transmitter provides over 4 watts rf output with over 10% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. It is designed to operate during the severe shock and vibration of aircraft operations. Operation is from nominal 400 CPS 115V single phase primary power. No heat sink or supplementary cooling required.

Model EM4575 is a complete transmitter, including a 400 CPS 115V power supply. All circuits are solid state, except the rf power oscillator, which is a single stage cavity using a rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter is packaged in less than 300 cubic inches, and weighs less than 11 pounds. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 2.2-2.3 Gc band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range —54°C to +55°C, without a heat sink or supplementary cooling.

Modulation Bandwidth and Linearity: Deviation of ±1.5 Mc is accomplished at ±2.5% linearity, ±500Kc at ±1% linearity, and ±300KC at ±0.5% linearity.

High Frequency Stability: Frequency drift does not exceed ±0.0025% of the operating carrier frequency, under all combinations of specified operating conditions.

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	2200-2300 Mc
Power Output, CW Minimum	4 Watts
Frequency Accuracy[4]	±0.0025%
Frequency Stability [4]	±0.0025%
Carrier Deviation, Adjustable, peak-to-peak	2Mc/Volt to 30Kc/Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 cps to 500 Kc
Flat within ±1 db	5 cps to 800 Kc
Modulation Linearity, Deviation from B.S.L.,	
For ±300 Kc peak Deviation	±0.5%
For ±1.5 Mc peak Deviation	±2.5%
Incidental Frequency Modulation, Maximum	±5 Kc
AM, Maximum, due to environmental conditions	1%
due to ±300 Kc carrier deviation	1%
due to ±1.5 Mc carrier deviation	5%
Modulation Input Impedance, Minimum, 5 cps to 800 Kc	50,000 Ohms shunted by 50 picofarads
Primary Voltage required[2]	100-150V, 350-450 cps, single phase
Primary power required, maximum	40 VA
Transients, Maximum positive withstood	300 volts for 1 microsecond —10 milliseconds
VSWR Maximum, any phase, for 4 watts output	2:1
for 2 watts output	5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-6181D are met
Life (without adjustment of controls), minimum	172 hours
(with servicing and maintenance), minimum	5000 hours

PACKAGING

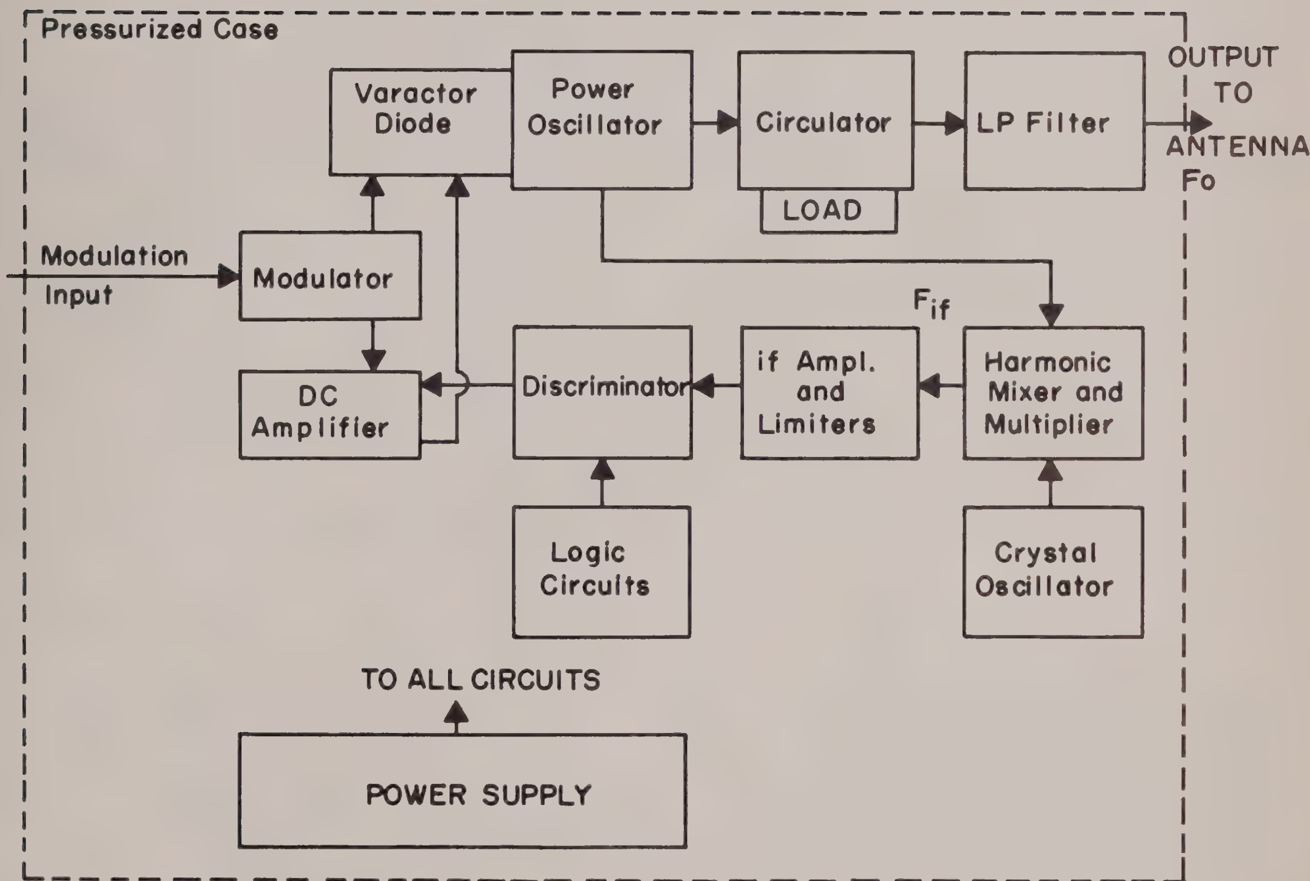
Volume displaced	280 cubic inches
Dimensions, including mounting flanges	7.5" x 6.063" x 8.0"
Weight	11 pounds
Pressurization	30 psia
Cooling	Convection
Connector, rf Output	Automatic Metals 100-N3001-85
Modulation Input	General RF 2007A
Power Input	Bendix PT07H-8-4P
Test Points	Bendix PT06H-10-6S

ENVIRONMENTAL SPECIFICATIONS[2]

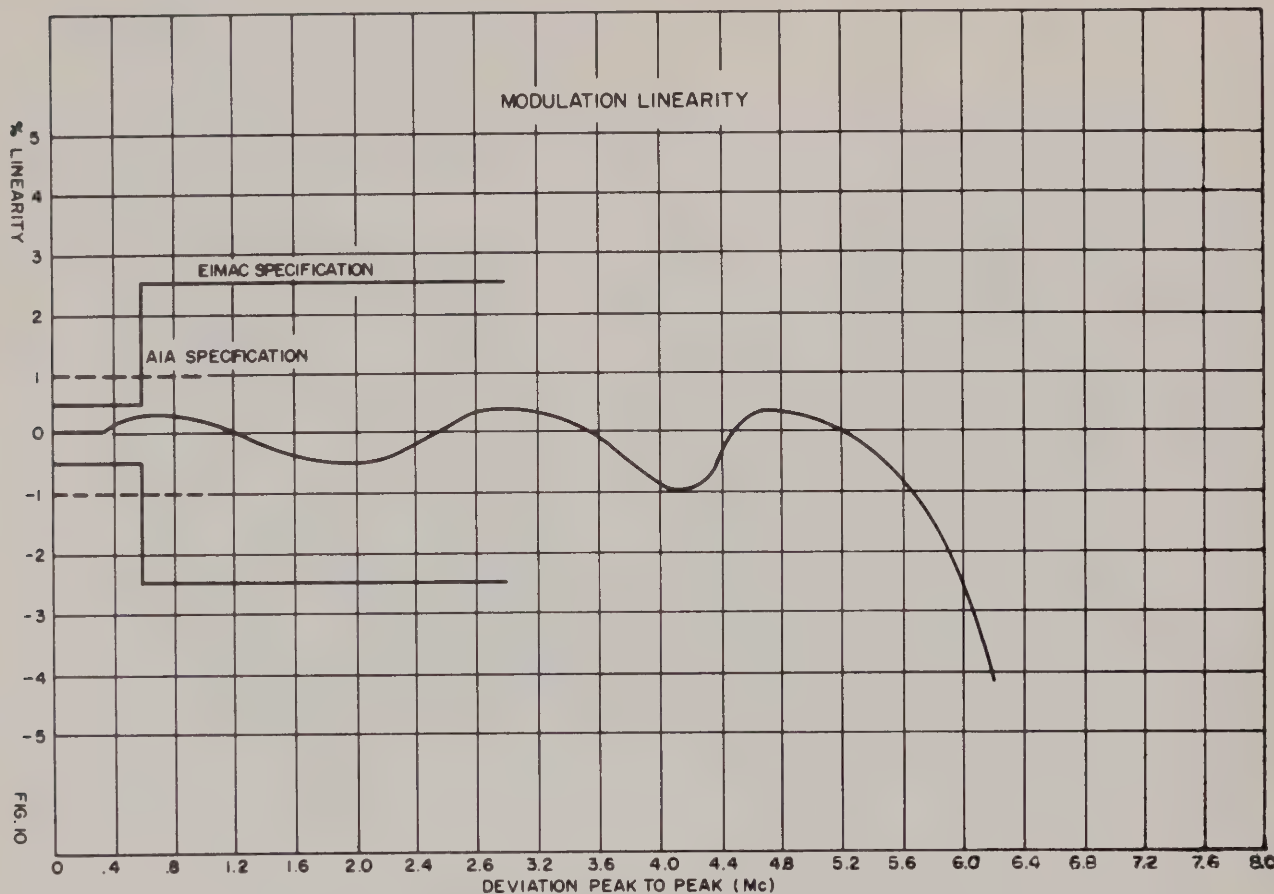
Temperature,[3] ambient (Continuous Operation)	—54°C to +55°C (MIL-T-21200, Class 1)
Altitude	30,000' with 30 psia internal pressure, any altitude with 20 psia pressure
Vibration	Per MIL-T-5422 Curve IV
Shock	Per MIL-T-5422
Salt spray, humidity	Per MIL-T-5422

[4]Available with frequency accuracy and stability of ±0.001% on special order.
[3]Other ranges available on special order.

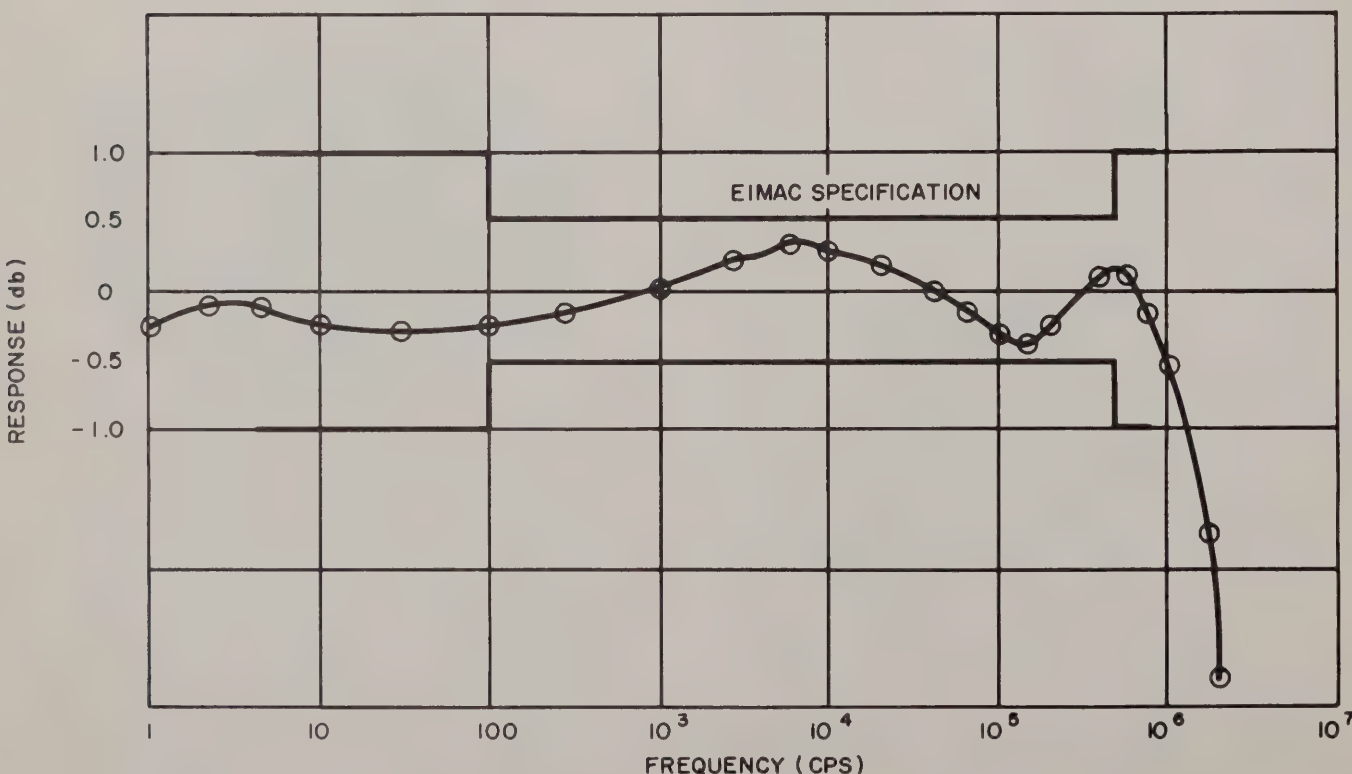
[1]Also available modified for modulation down to DC.
[2]Transmitter performs as specified, under any combination of environmental conditions.



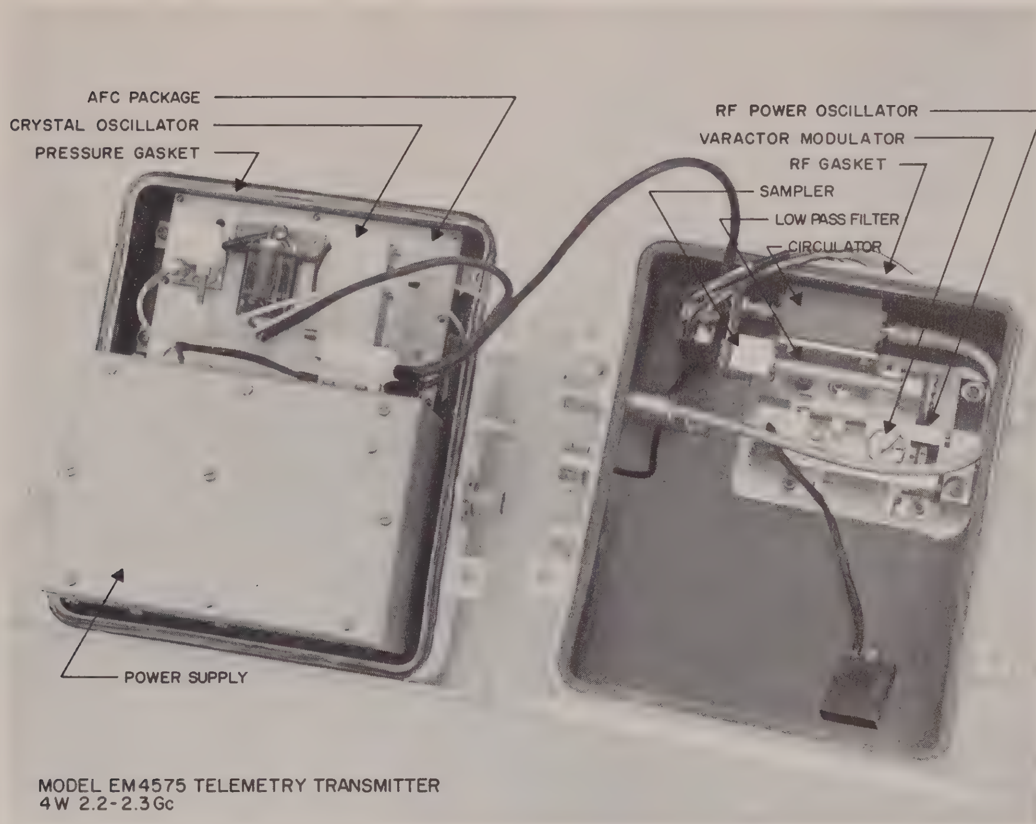
BLOCK DIAGRAM
MODEL EM4575 4W S-BAND TELEMETRY TRANSMITTER



MODULATION LINEARITY OF EM4575 TRANSMITTER

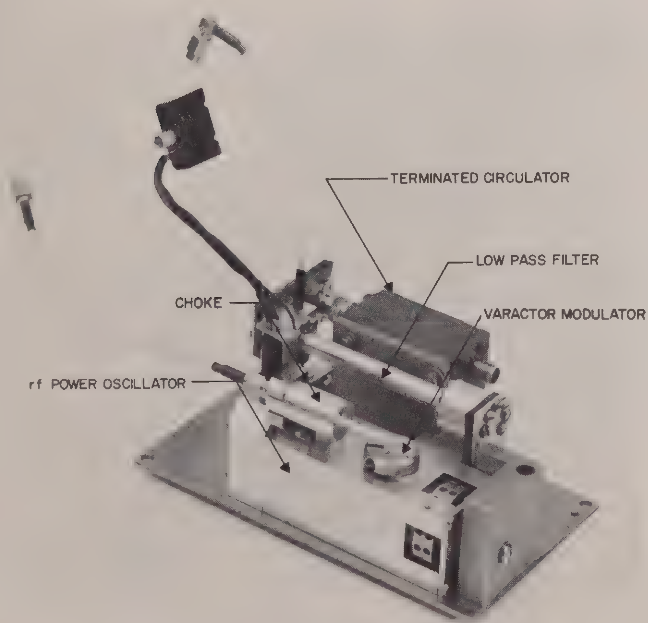


MODULATION FREQUENCY RESPONSE OF EM4575 TRANSMITTER



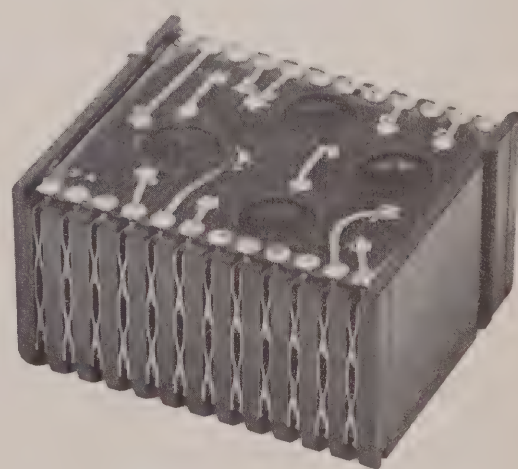
EM4575 TELEMETRY TRANSMITTER ASSEMBLY

Packaging of this transmitter is compact, yet all modules are easily accessible. The covers incorporate pressure seals and rfi gaskets.



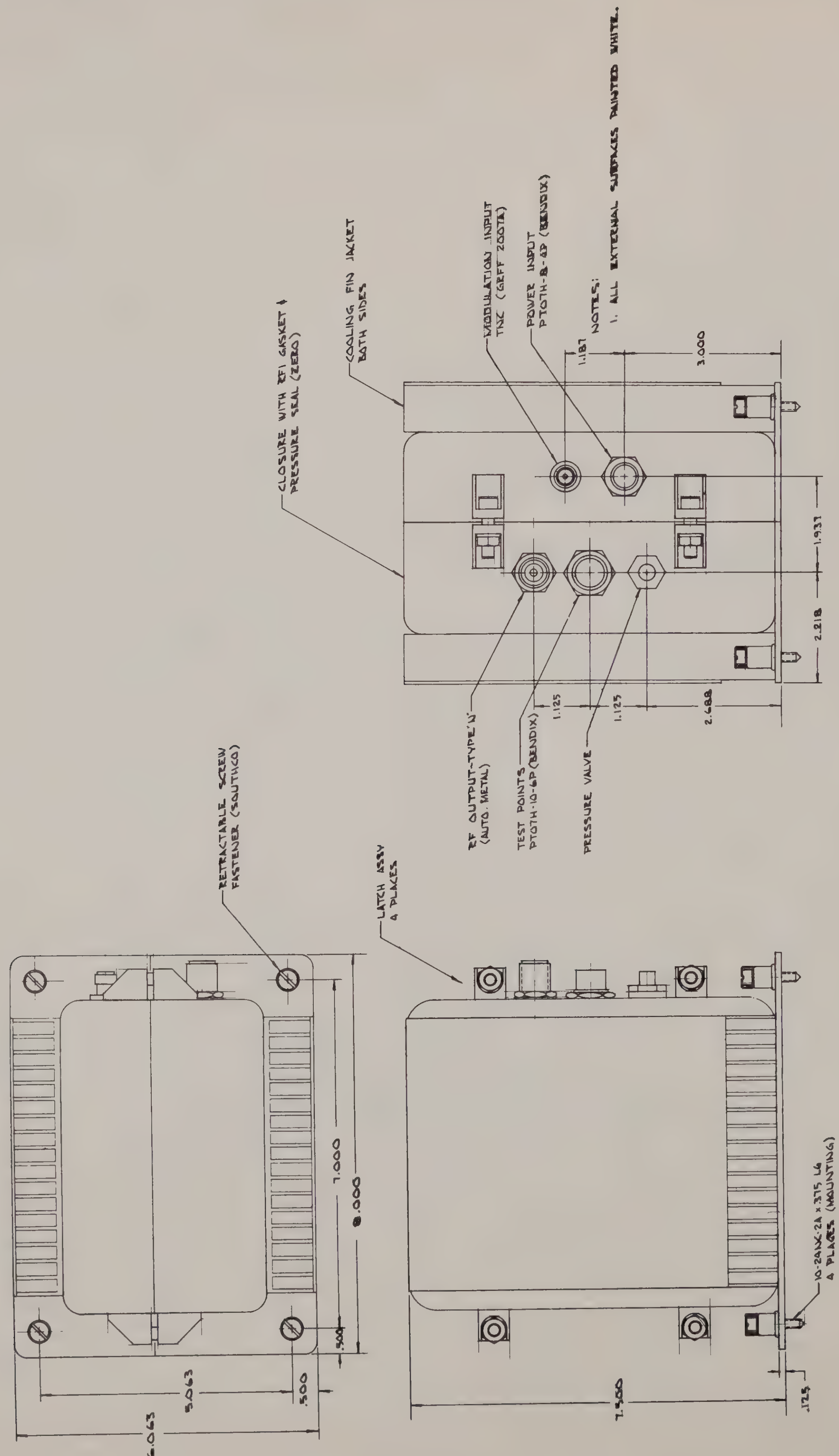
RF SECTION, EM4575 TRANSMITTER

The rf power oscillator provides over 4 watts, tunable 2.2-2.3 Gc. There is no output below 2.2 Gc. Harmonics are removed by a low pass filter. The ceramic planar triode in the oscillator is conduction cooled to the transmitter case.



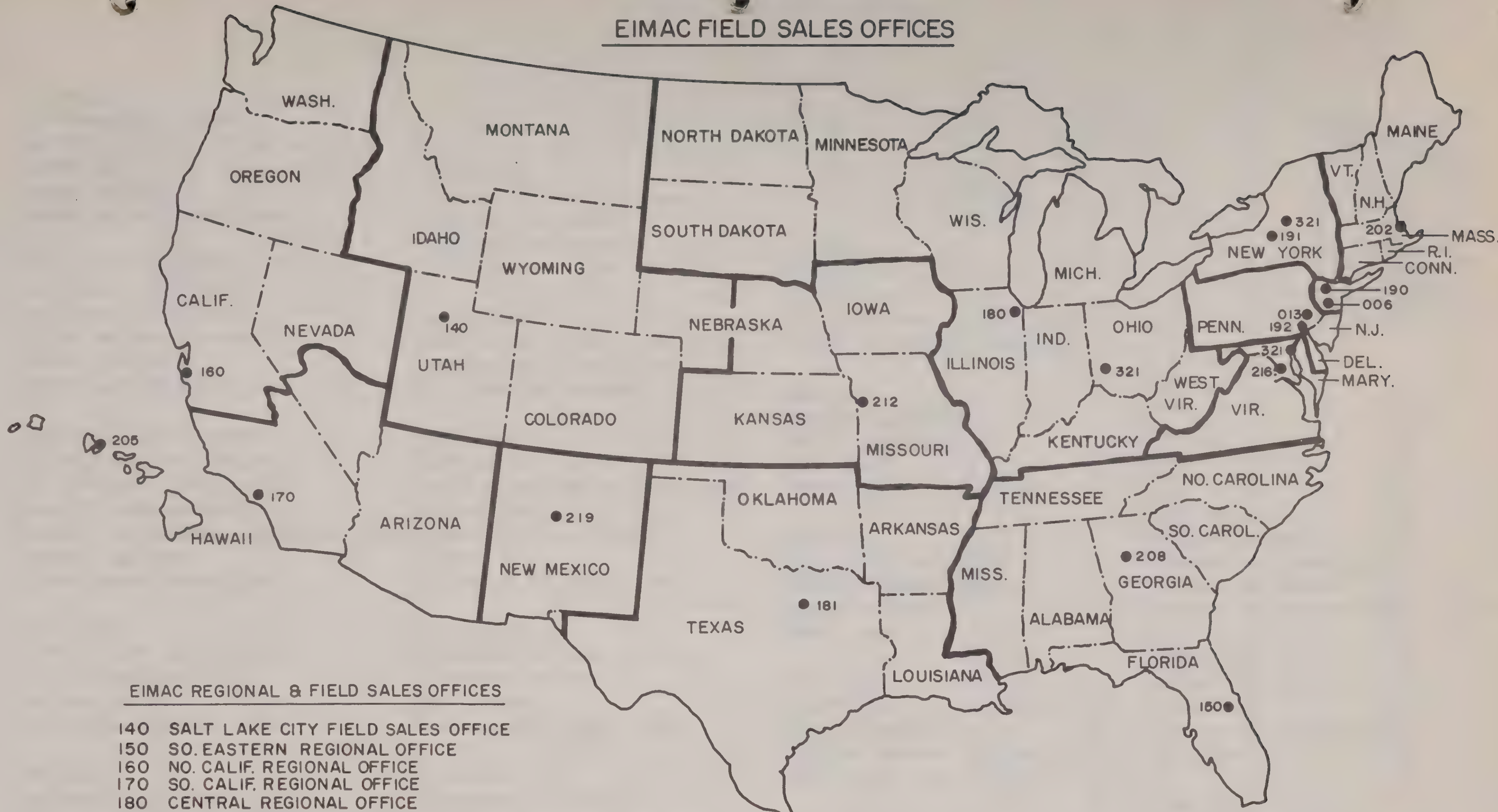
TYPICAL PLUG-IN MODULE

AFC servo circuits use only high reliability components such as silicon planar transistors and are packaged in modular form. The modules are easily removable, and offer flexibility for future modification. The connector system provides four redundant contacts at each connection. All modules are encapsulated with a rigid high thermal conductivity compound for heat conduction and vibration protection.


CLOSURE WITH RFI GASKET & PRESSURE SEAL (ZERO)
COOLING FIN JACKET BOTH SIDES
MODULATION INPUT TNC
POWER INPUT PT07H-8-4P (BENDIX)
NOTES:
1. ALL EXTERNAL SURFACES PAINTED WHITE.
RF OUTPUT-TYPE 'N' (AUTO. METAL)
TEST POINTS PT07H-10-6P (BENDIX)
PRESSURE VALVE
RETRACTABLE SCREW FASTENER (SOUTHCO)
LATCH ASSY 4 PLACES
10-24NC-2A x .375 LG 4 PLACES (MOUNTING)
1.187
3.000
1.937
2.218
1.125
1.125
2.688
7.000
8.000
.500
5.063
.500
6.063
7.500
.125

EITEL-M ULLOUGH, INC.

EIMAC FIELD SALES OFFICES



EIMAC REGIONAL & FIELD SALES OFFICES

140 SALT LAKE CITY FIELD SALES OFFICE
150 SO. EASTERN REGIONAL OFFICE
160 NO. CALIF. REGIONAL OFFICE
170 SO. CALIF. REGIONAL OFFICE
180 CENTRAL REGIONAL OFFICE
181 DALLAS REGIONAL OFFICE
190 EASTERN REGIONAL OFFICE
191 UPPER STATE N.Y. FIELD SALES OFFICE
192 PHILADELPHIA FIELD SALES OFFICE
321 WASHINGTON LIAISON OFFICE

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162 NO. CALIF. DISTRIBUTOR ORDERS

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205 BILL KOLANS & CO.
208 J.E. JOYNER & ASSOC.
212 MAURY BETTIS CO. (12/1/65)
216 JAMES R. EBERLY CO.
219 BOWDEN ENG. & SALES CO.

EIMAC GOVERNMENT REPRESENTATIVES

321 T. RIZZUTI
321 ROBT. G. SIFF & ASSOC.

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1 JUNE 1965

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758-7496

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Rome, New York
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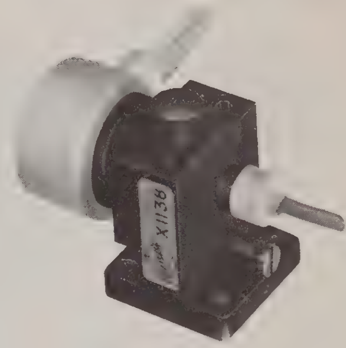
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Tentative Data

X1138 SERIES

K BAND REFLEX KLYSTRON

The Eimac X1138 series of ruggedized ceramic/metal reflex klystrons operates in the 20 to 30 Gc region with long life and high reliability. X1138 series tubes will deliver power outputs of 200 mW at a voltage of only 550 V over a 1000 Mc mechanical tuning range. External cavity tuning makes possible very stable operation.



The X1138 was designed for application as a parametric amplifier pump source where excellent frequency and power stability are required. It also finds application in water absorption measuring equipment, microwave spectroscopy, and as a local oscillator.

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE	Operating Voltages* 300 V	400 V	550 V	
Frequency	20 to 30	20 to 30	20 to 30	(Gc)
Mechanically Tunable	0 to 1000	0 to 1000	0 to 1000	(Mc)
Power Output	25	100	200	(mW)
Electronic Tuning Range (3 db bandwidth)	30	50	90	(Mc)
Resonator Voltage	300	400	550	(Vdc)
Cathode Current	16	25	35	(ma)
Repeller Voltage	—250	—275	—375	(Vdc)
Repeller Modulation Sensitivity (3 db sweep)	1.0	1.4	1.7	(Mc/v)
Heater Voltage	6.3 ±5%	6.3 ±5%	6.3 ±5%	(Vac)
Heater Current	1.0	1.0	1.0	(amps)
Temperature Coefficient	±250	±250	±250	(Kc/°c)
Warm-up Time	20	20	20	(sec)

MAXIMUM RATINGS

Resonator Voltage	550 (Vdc)
Cathode Current	40 (ma)
Repeller Voltage (Negative with respect to cathode)	—50 to —700 (Vdc)

Note: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Electrical Connections (Type)	Flying leads
RF Output Coupling:	
(a) Flange size	UG595/u or UG599/u
(b) Waveguide size	RG53/u or RG96/u
Cooling Required	Conduction cooled thru waveguide flange*
Net Weight	Approx. 4 oz.

ENVIRONMENTAL PERFORMANCE

Temperature Range	Maintain flange temp. under 100°C
Altitude	100,000 ft.
Vibration	10 G, 10-1000 CPS
Shock	100 G, 11 msec

*See Application Notes

Printed in U.S.A.

APPLICATION NOTES

Operating Voltages

For maximum performance, the tube must be factory preset for the desired operational voltage.

Cooling

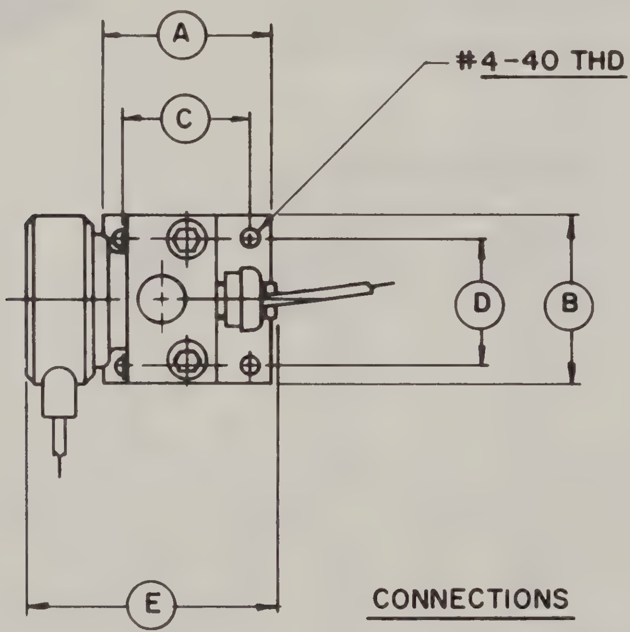
When run with the resonator off ground (i.e. insulated from waveguide), sufficient air cooling will be required to maintain the flange temperature of the tube below 100°C.

Resonator

The resonator of the X1138 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode

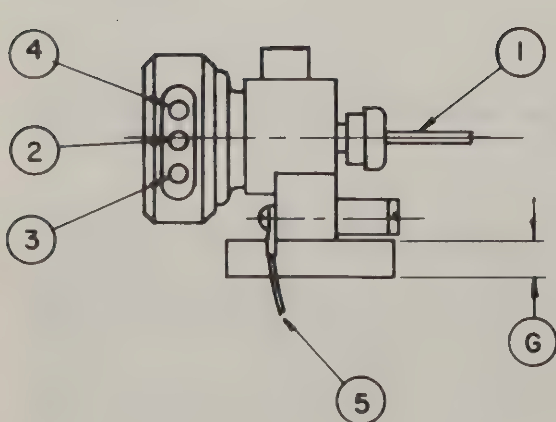
The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. The heater and cathode of the X1138 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

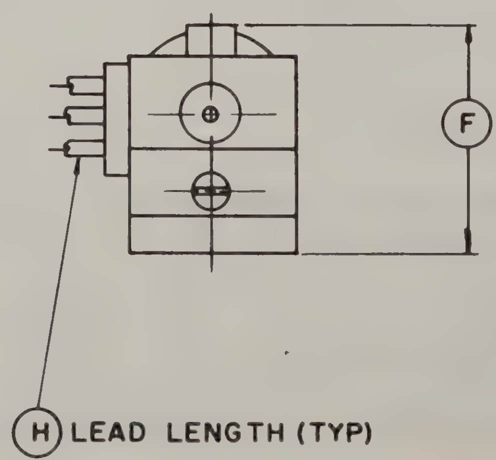


DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	.865	.885	
B	.865	.885	
C	.665	.675	
D	.635	.645	
E		1.375	
F		1.750	
G	.180	.200	
H	11"		

CONNECTIONS

1. REPELLER — GREY
2. HEATER — YELLOW
3. CATHODE - GREEN
4. HEATER & CATHODE — WHITE
5. GROUND - BROWN





EM4539

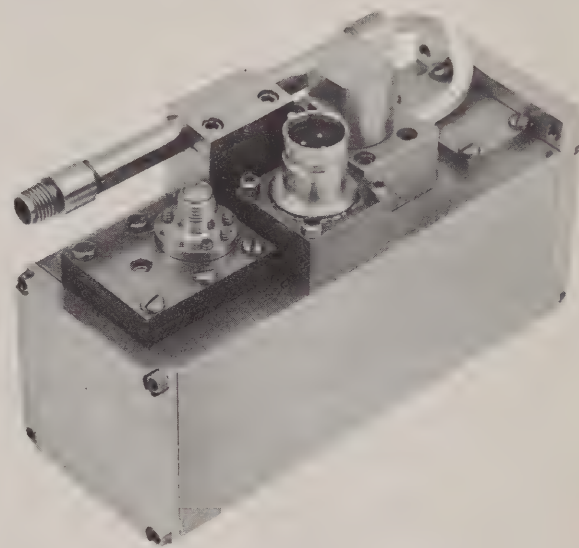
CAVITY AMPLIFIER

1420-1600 Mc

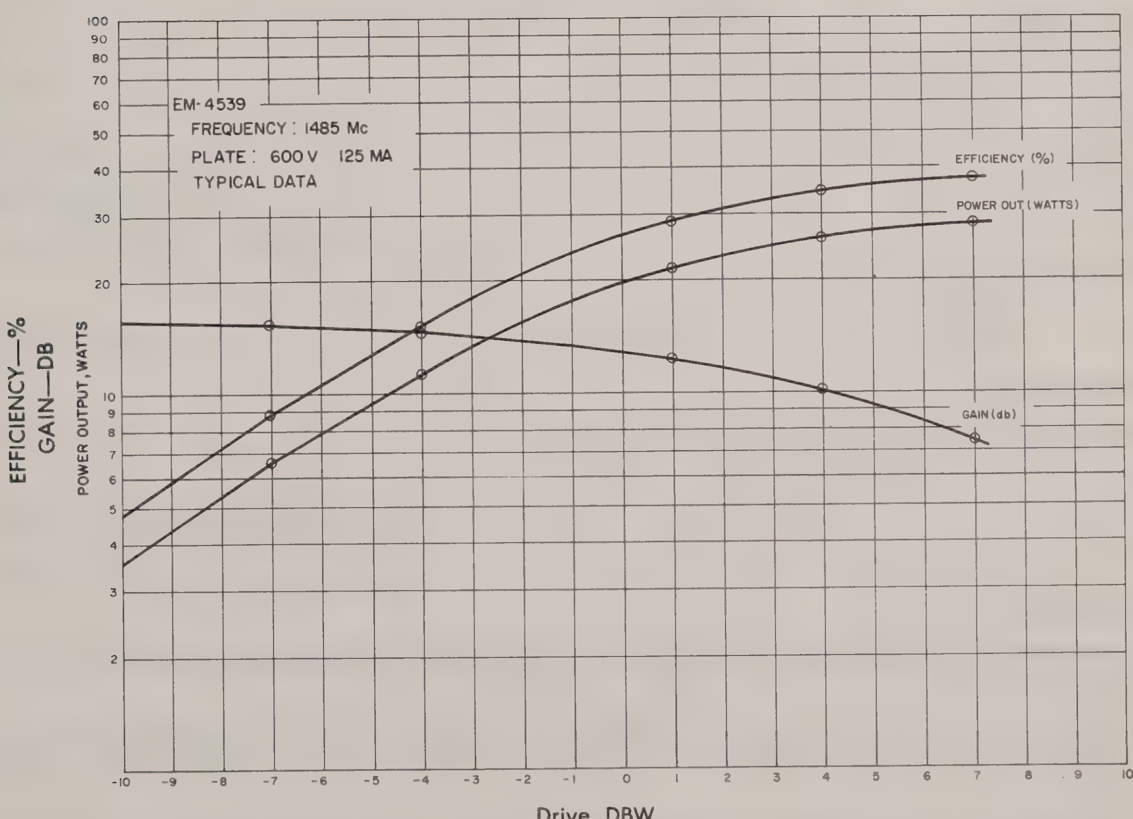
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

The Eimac EM4539 is a miniaturized 20 watt cavity amplifier incorporating a ceramic-metal planar triode. It is intended for use in aerospace telemetry transmitters and special aerospace transmitters.

A recommended DC-DC converter for use with this amplifier is Eimac Model EM4590.



EM4539 CAVITY AMPLIFIER



EM4539 AMPLIFIER

CHARACTERISTICS

ELECTRICAL

Frequency,[1] continuously tunable	1420-1600 Mc
Rf power[2] output (with 2 watts drive)	

Frequency, Mc	Power output, Watts, CW
1420-1435	15
1435-1535	20
1535-1600	15

Input Signals	All standard FM telemetry signal formats, per IRIG 106-60
Bandwidth, Minimum, 3 db points	10 Mc
Gain, Minimum, 1435-1535 Mc	10 db
Load Impedance, nominal	50 ohms
VSWR, Maximum, for full rated output	1.5:1
without damage	3:1
Efficiency,[2] Overall, Minimum	25%
Phase jitter, Maximum, between input and output	5° peak
Power Supply Requirements[3]	
Anode voltage	600 Volts
Current	125 mA
Heater voltage	6.0 Volts
Current	1.0 Amperes
Harmonic Suppression (2nd, 3rd and 4th of 1435-1535 Mc)	60 db
Warm-up Time	3 Minutes

MECHANICAL

Size, Overall (including protrusions)	4" x 2½" x 1½"
Weight	1.1 pounds
Mounting	To Heat Sink (not included)
Tuning Controls	Three (all on same surface)
Cooling	Conduction to Heat Sink at –54°C to +95°C
Connectors: rf input	OSM
rf output	OSM
Power	Deutsch #DM 5300-3P-643

ENVIRONMENTAL

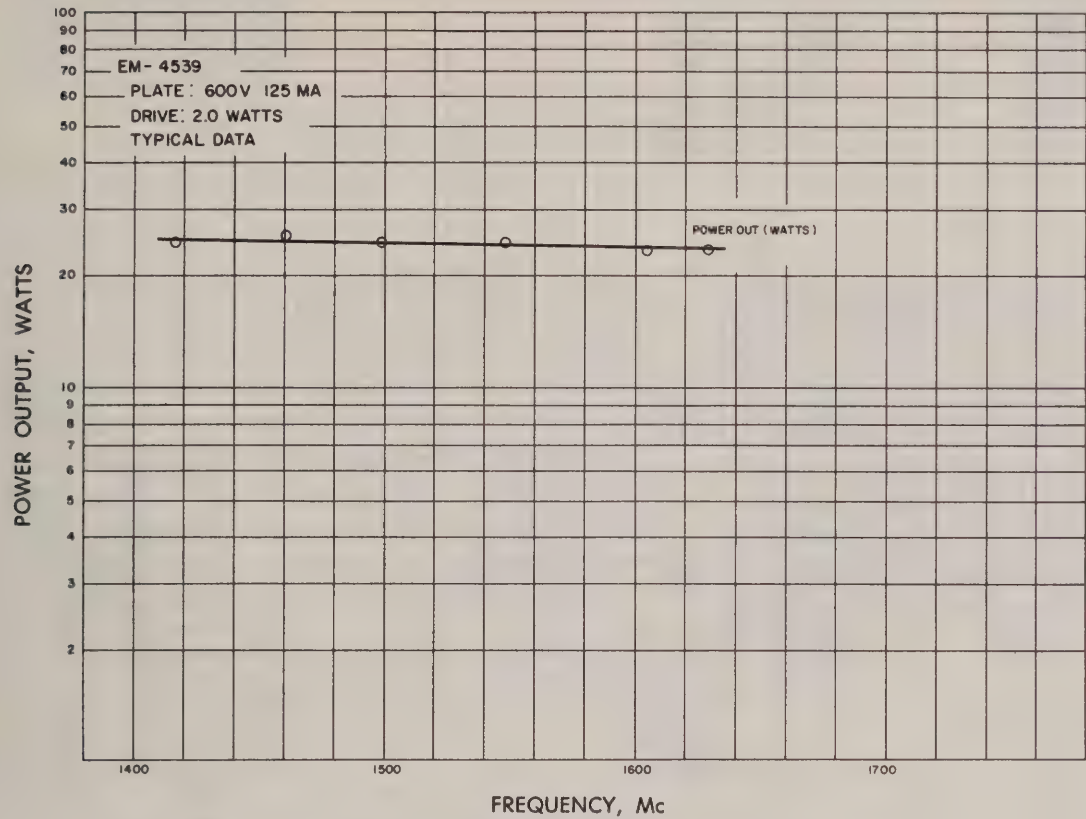
Temperature, heat sink, for continuous operation	–54°C to +95°C
Altitude	Any
Vibration	20g, 20-2000 cps, 3 major axes
Other	Per MIL-E-5400

FOOTNOTES:

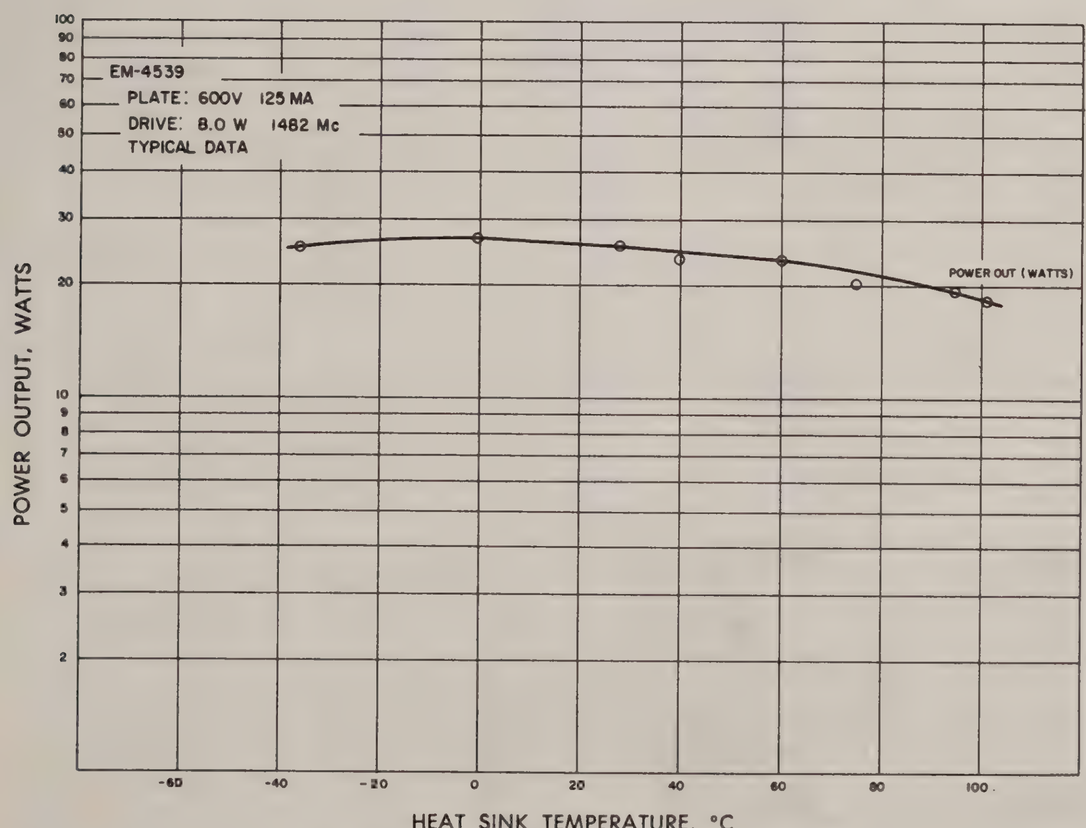
(1) Also available with similar performance characteristics for other frequencies in the 900-2500 Mc range.

(2) Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions. See curves for typical output and efficiency with other drive levels.

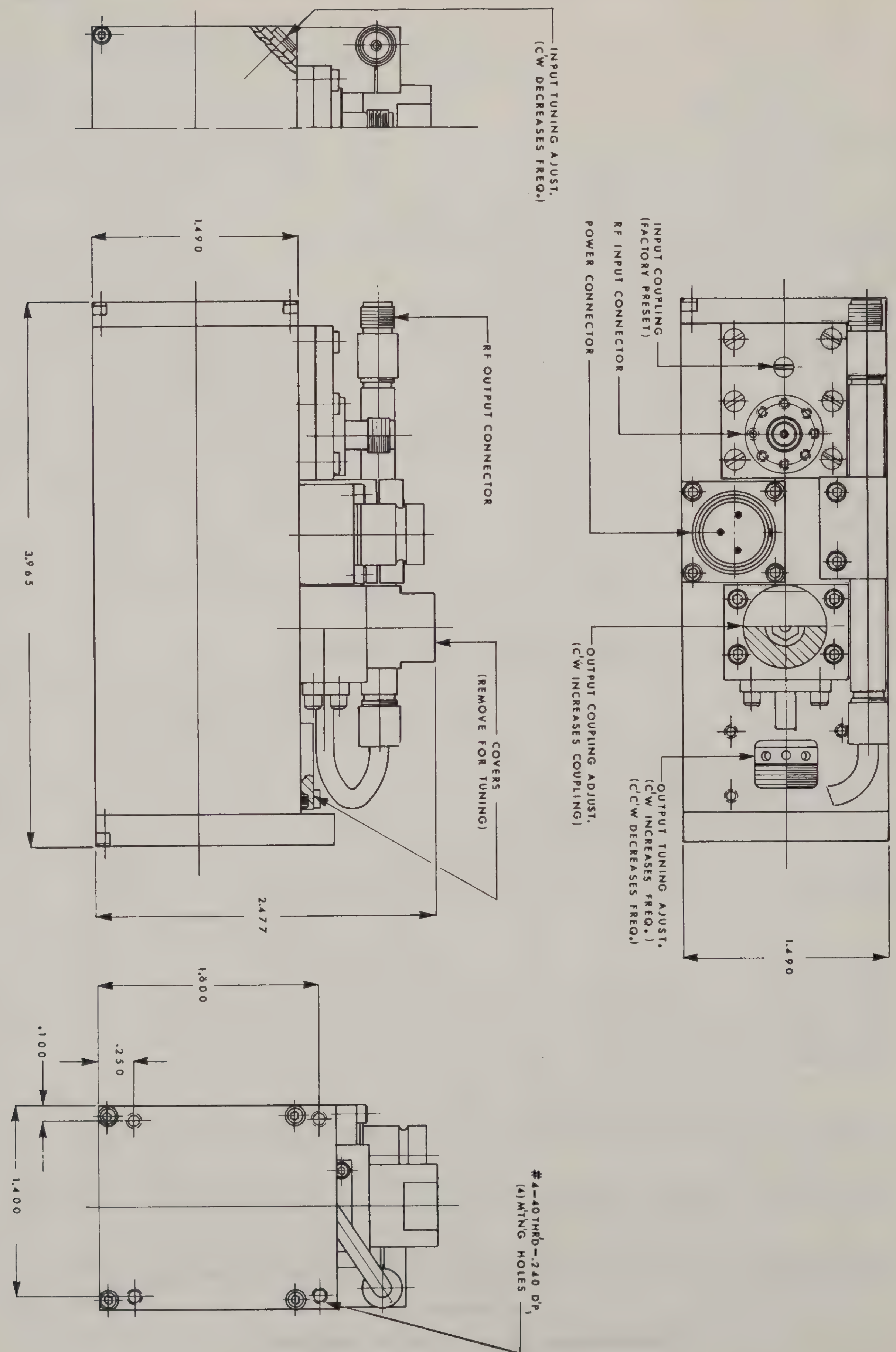
(3) A separate DC-DC converter package, Model EM4590, operating from 28 +8/–4 Vdc, is available from Eimac. Power supplies for operation from other primary sources are available on special order.



TUNING RANGE, EM4539 AMPLIFIER



TEMPERATURE EFFECT, EM4539 AMPLIFIER



OUTLINE DIMENSIONS, EM4539 AMPLIFIER

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

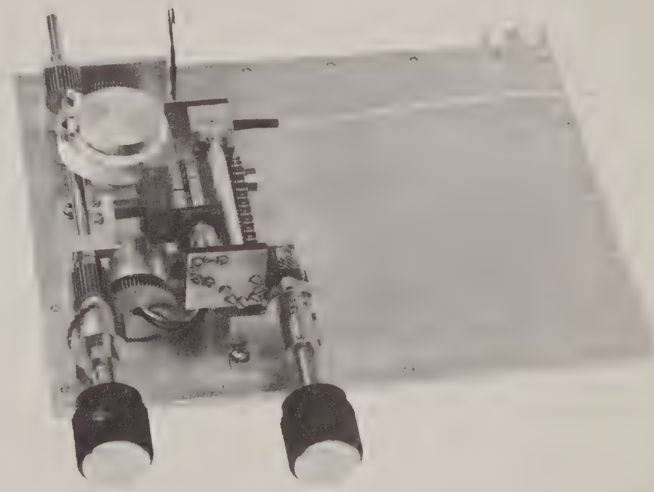
EM4574 EM4585 EM4586

CW OSCILLATOR

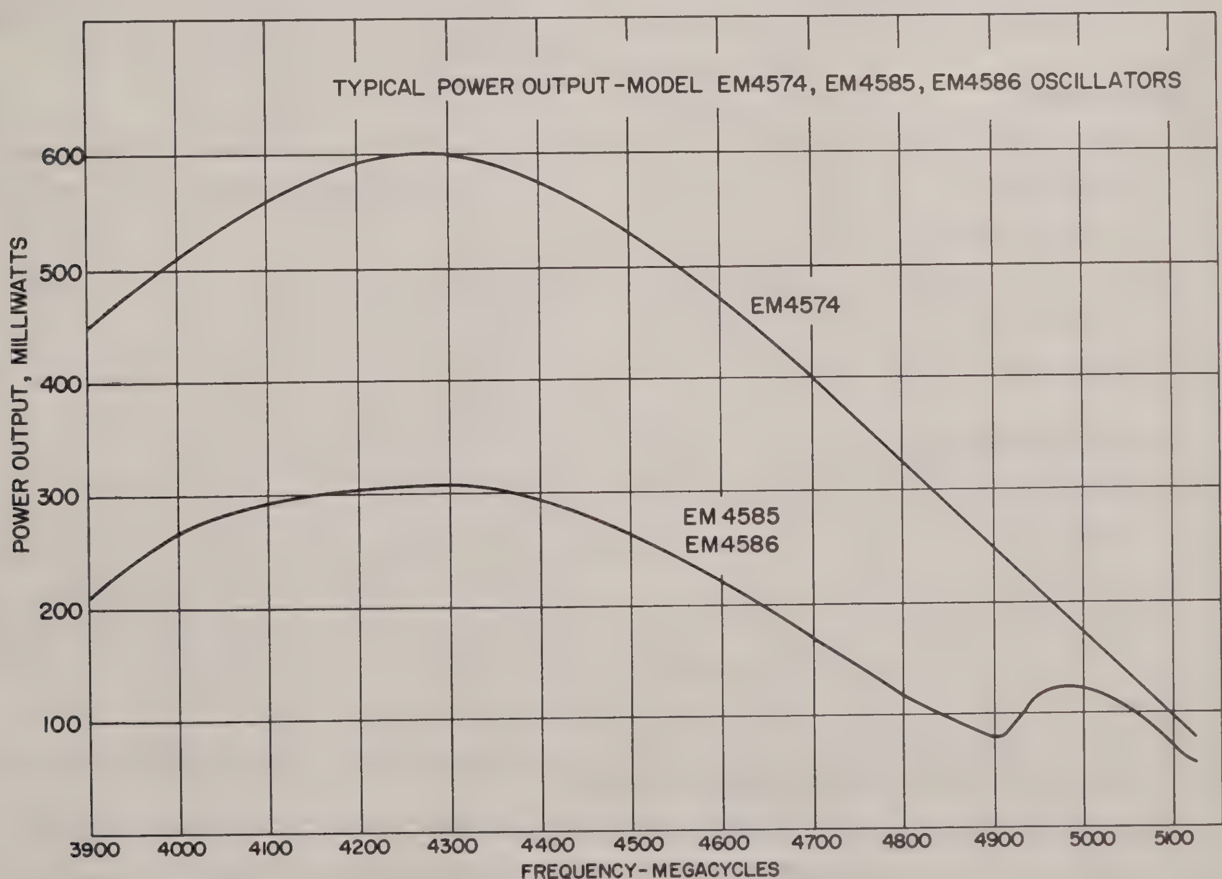
3900-5100 Mc

The Eimac EM4574 is a CW oscillator providing up to 600 milliwatts output, tunable 3.9-5.1 Gc. It is also available as an electronically tunable oscillator, EM 4585, including a varactor diode modulator. A complete package of the EM4585 electronically tunable oscillator with low pass filter, terminated circulator and tuning mechanism for single knob front panel tuning is available, Model EM4586. This oscillator is recommended for use in aerospace and ground system transmitters.

A DC-DC converter, EM4589, is available to operate this oscillator from a 28 V DC primary power supply.



EM4586 OSCILLATOR



CHARACTERISTICS

ELECTRICAL

Frequency, Manual Tuning Range	3900-5100 Mc
Electronic Tuning Range	±15 Mc

RF Power Output

Frequency, Mc	Power output, Milliwatts, CW EM4574	EM4585/EM4586
3900	400	200
4300	550	300
4700	350	150
5100	75	50

Frequency Stability, Parts/million/°C	±10	
Power Supply Requirements:	Voltage	Current
Anode, maximum	150	35 mA
Grid Current, maximum		5 mA
Heater	6.0 V	0.3A
Ground	Positive terminal of anode supply	
Tube Type	Eimac 128676	
Load Impedance	50 ohms nominal	
Load VSWR, maximum	1.5:1, any phase (5:1 without damage)	
Modulation	CW/FM	

MECHANICAL

Mounting	To Heat Sink (See photograph)
Size, EM4574	Length 4.5 in.; Width 1.0 in.; Depth 1.0 in.
Weight, EM4574	0.5 pounds
EM4586	1.9 pounds
Cooling	Conduction
Connector	Type TNC Female

ENVIRONMENTAL (Operational)

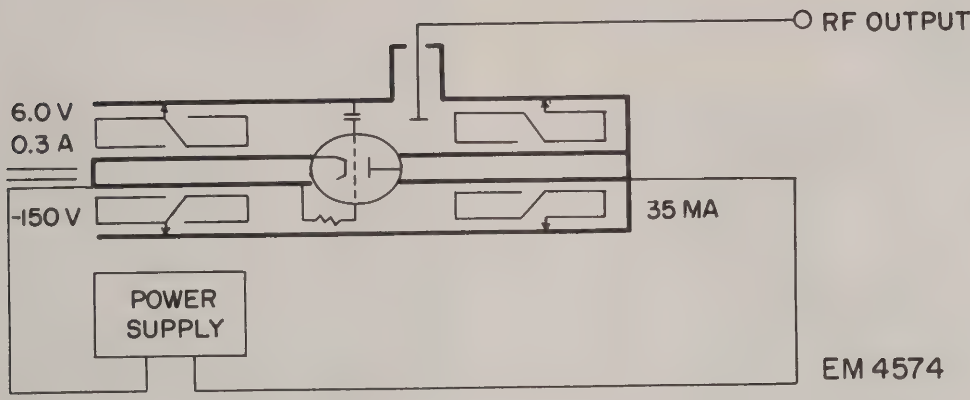
Temperature	—40 to +100°C
Altitude	0 to 5,000 feet
Vibration	5 to 33 CPS at 0.3 inches amplitude
Shock Withstood	300 g sawtooth for 1 millisecond

NOTES:

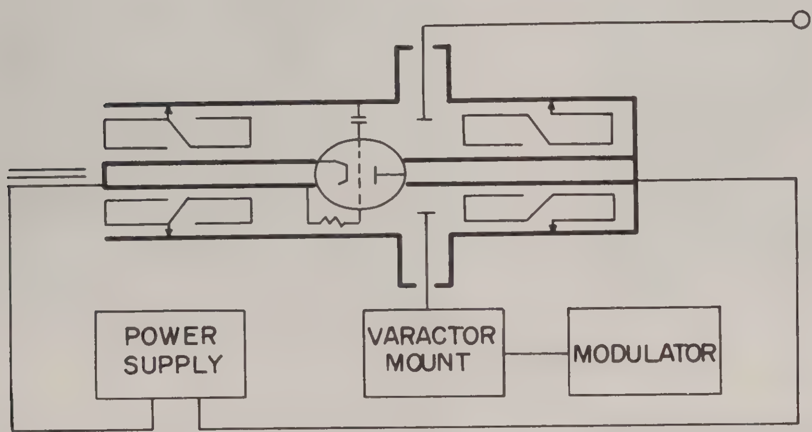
(1) *Carrier Deviation* of EM4585 and EM4586 is adjustable from ±3 Kc to ±300 Kc with 0.2 to 1.0 volts peak-to-peak modulating input voltage.

(2) *Modulation Bandwidth* of EM4585 and EM4586 is flat within 1 db, 500 CPS to 150 Kc.

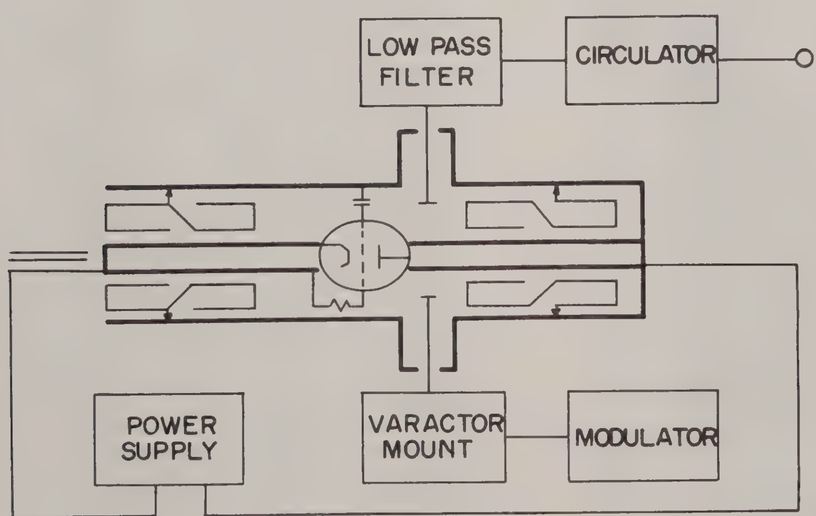
(3) *Modulation Linearity* of EM4585 and EM4586: deviation from BSL less than ±0.5%, ±6 Kc to 300 Kc.



EM 4574



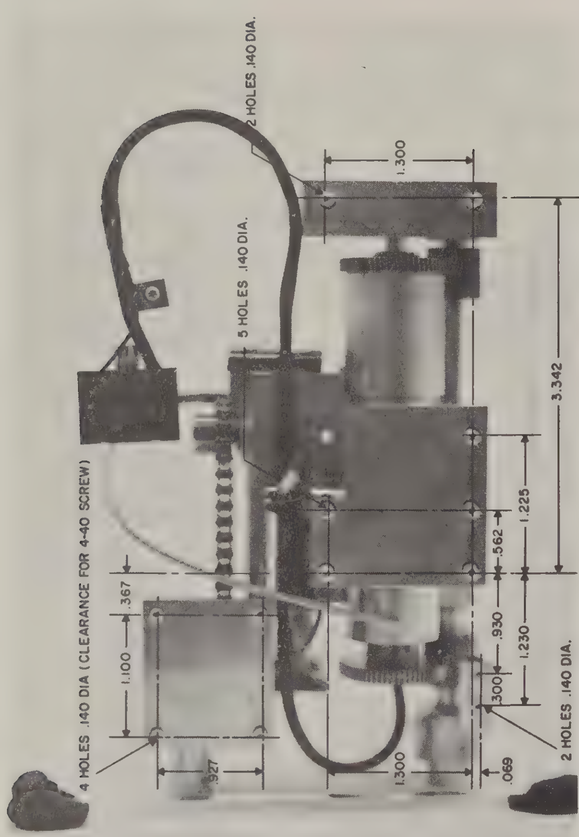
EM 4585

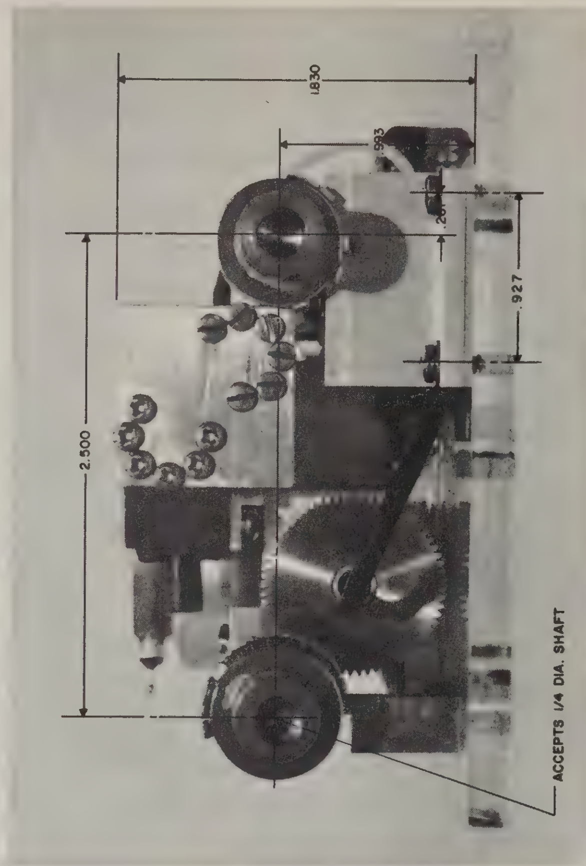


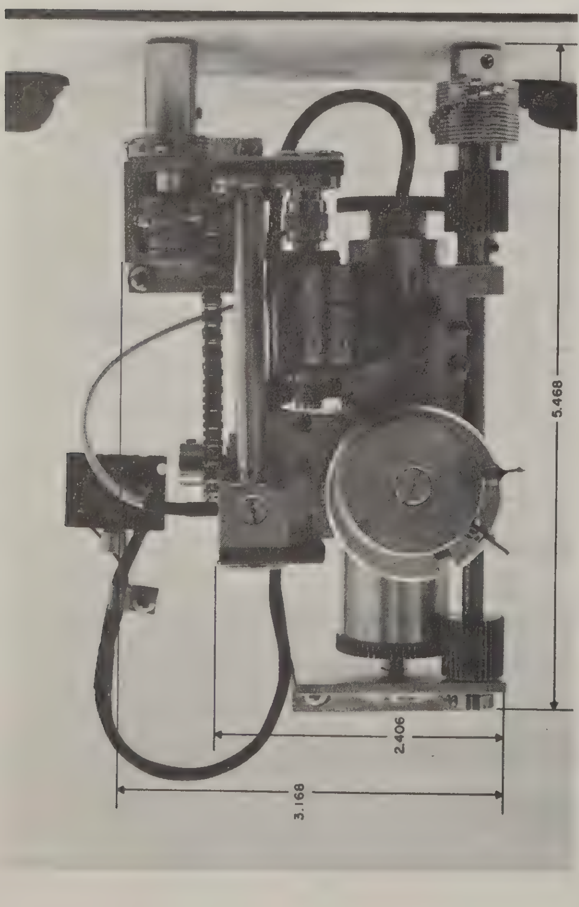
EM 4586

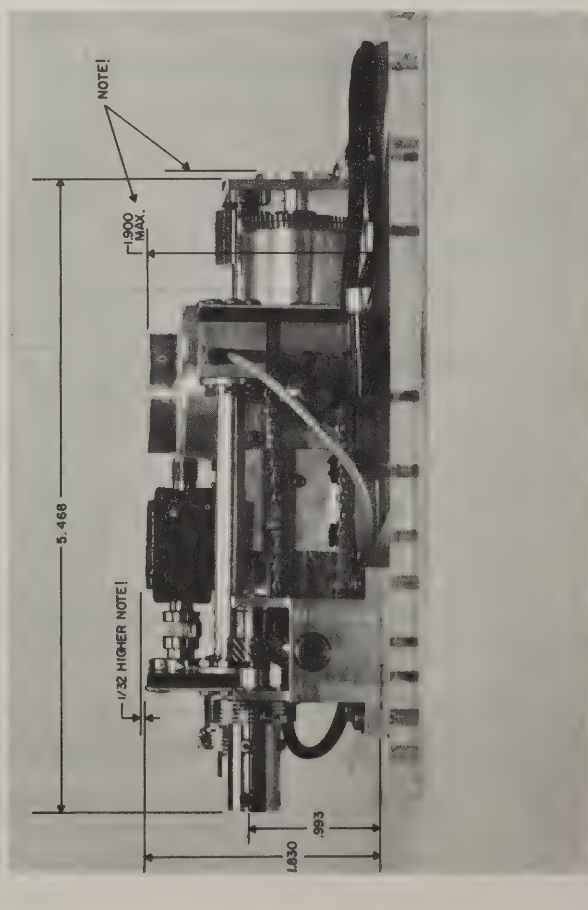
EIMAC C-BAND CW POWER OSCILLATORS

POWER SUPPLY MUST BE PURCHASED SEPERATELY.


2 HOLES .140 DIA.
1.300
5 HOLES .140 DIA.
3.342
4 HOLES .140 DIA (CLEARANCE FOR 4-40 SCREW)
.367
1.100
.927
1.225
.562
.930
1.230
.300
2 HOLES .140 DIA.
1.300
.069


1.830
.993
.927
2.500
ACCEPTS 1/4 DIA. SHAFT


5.468
2.406
3.168


NOTE!
1.900 MAX.
5.468
1/32 HIGHER NOTE!
.993
1.830

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

3KM3000LA

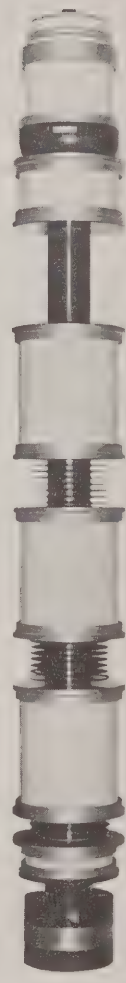
POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 3KM3000LA is a three-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 375 and 585 megacycles. This klystron will deliver a narrow-band CW output power of 2 kilowatts with a power gain of 28 decibels. When adjusted for wide-band operation, the 3KM3000LA will deliver an output power of one kilowatt with a half-power bandwidth of 3 megacycles and a power gain of 23 decibels.

This klystron can be pulsed or amplitude modulated with minimum power by utilizing its modulating anode. Effective protection against internal arcs is provide by connecting the modulating anode to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assemblies H-120 and H-205 are available for use with the 3KM3000LA. The H-120 Assembly is suitable for fixed-station service, but the H-205 Assembly is recommended for van-mounted or shipboard installations. Each assembly includes a klystron supporting structure, focusing coils, tuning cavities, adjustable load coupler and an Eimac SK-100 Air-System Socket.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage	5 (±5%) volts
Current (nominal)	31 amperes
Nominal Cold Resistance	0.02 ohms
Cathode: Unipotential, Oxide Coated	
Heating Time	5 minutes
Power Gain: (Narrow Band)	28 decibels
Output Power (Narrow Band)	2 kilowatts
Frequency Range	385 to 585 megacycles

MECHANICAL

Operating Position	Axis vertical, cathode up
Coupling (rf):	
Input	Type "N" coaxial fitting
Output	1⅝ inch, 50-ohm line
Middle Cavity Loading	Type "N" coaxial fitting
Weights:	
3KM3000LA Klystron	46 lbs.
H-120 Circuit Assembly	570 lbs.
H-205 Circuit Assembly	600 lbs.

Cooling: Forced Air	*Flow Rate*	*Pressure Drop*
Cathode (with SK-100 Air-System Socket)	*5 cfm	0.4 inch H_2O
Output Cavity	*50 cfm	1.0 inch H_2O
Klystron Collector	*150 cfm	1.6 inches H_2O

*At sea level with 20°C inlet air temperature.

FOCUS-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil: Voltage	0 to 25	volts
Current	0 to 1.25	amperes
Each of Two Body Coils:		
Voltage	0 to 175	volts
Current	0 to 3	amperes
Collector-Coil Voltage	0 to 50	volts
Collector-Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

BEAM VOLTAGE (PULSE OPERATION)	20	KILOVOLTS (dc)
BEAM VOLTAGE (CW OPERATION)	9	KILOVOLTS (dc)
PEAK BEAM CURRENT	2.8	AMPERES
BEAM CURRENT (CW OPERATION)	750	MILLIAMPERES (dc)
BODY CURRENT (CW OPERATION)	75	MILLIAMPERES (dc)
FOCUS-ELECTRODE VOLTAGE	–500	VOLTS (dc)
COLLECTOR DISSIPATION	3	KILOWATTS

TYPICAL OPERATION

NARROW-BAND PULSE AMPLIFIER, 400-450 MEGACYCLES, 0.06 DUTY, MODULATING ANODE PULSED

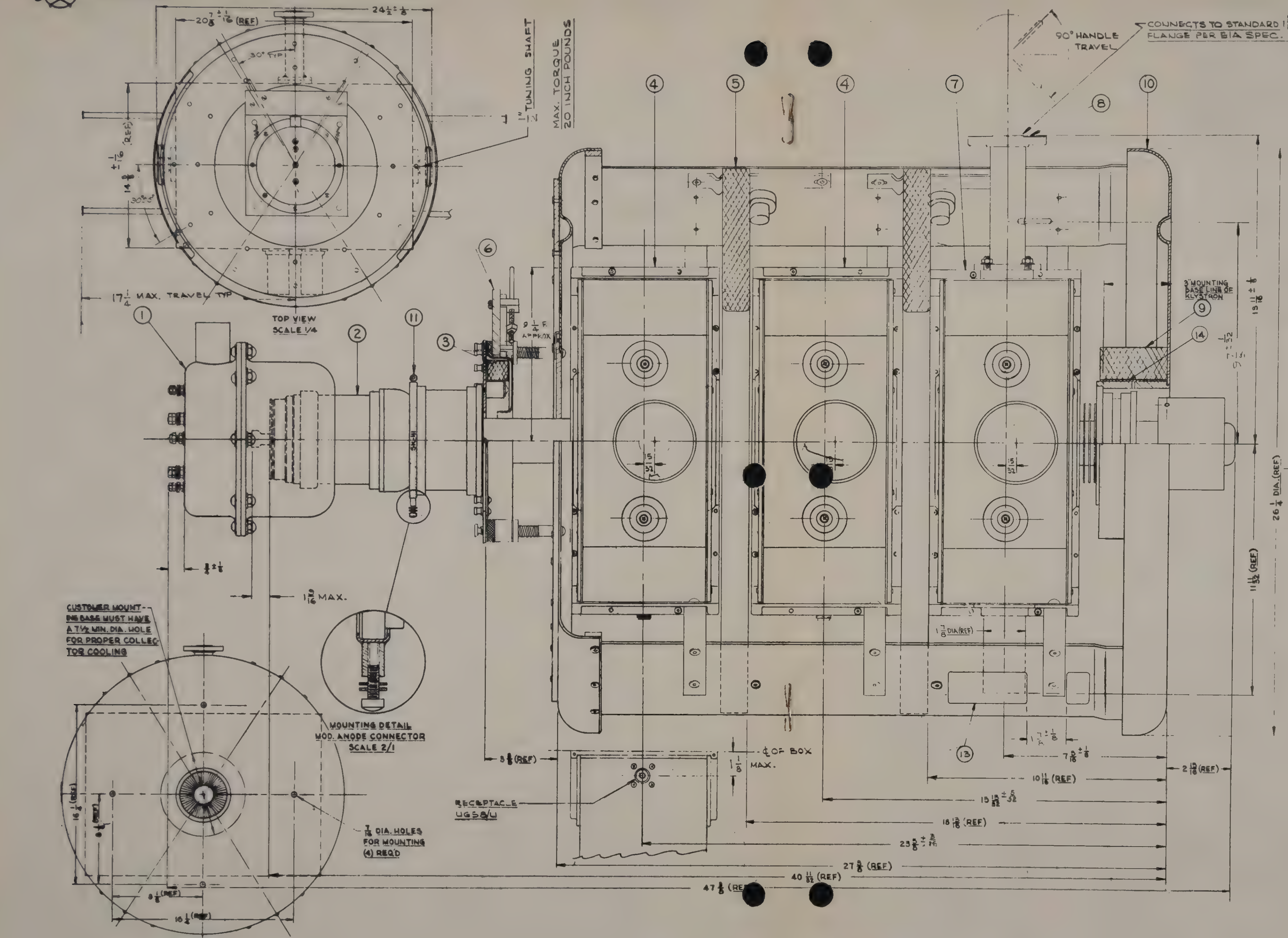
Peak Output Power	12.25	kilowatts
Peak Driving Power	10	watts
Peak Power Gain	30.9	db
Beam Voltage	15	kilovolts, dc
Peak Beam Current	1.74	amperes
Peak Beam Input Power	26.2	kilowatts
Peak Beam Power Efficiency	47	percent
Peak Body Current	100	milliamperes
Peak Collector Current	1.64	amperes
Peak Modulating-Anode Voltage	15	kilovolts
Focus-Electrode Voltage	0	volts
Focus-Coil Currents:		
Prefocus	1.0	ampere
First Body	2.7	amperes
Second Body	2.7	amperes
Collector	1.5	amperes

TYPICAL OPERATION — CW AMPLIFIER

	Narrow Band		Wide Band	
Frequency	520	520	400	megacycles
Output Power	0.9	2.3	1	kilowatts
Driving Power	1	2	3	watts
Power Gain	29.5	30	25.2	db
Beam Voltage	6	9	7.5	kilovolts dc
Beam Current	370	590	475	milliamperes dc
Beam Power Efficiency	40.5	43.4	28	percent
Body Current	25	40	18	milliamperes dc
Middle Cavity Loading	0	0	22	watts
3 db Bandwidth	0.6	0.8	3.5	megacycles
Focus-Electrode Voltage	—200	—200	—100	volts
Focus-Coil Currents:				
Prefocus	0.65	0.7	0.7	ampere
First Body	2.0	2.0	2.0	amperes
Second Body	1.1	1.6	1.5	amperes
Collector	1.0	1.0	1.0	ampere

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, Calfornia.

3KM3000LA

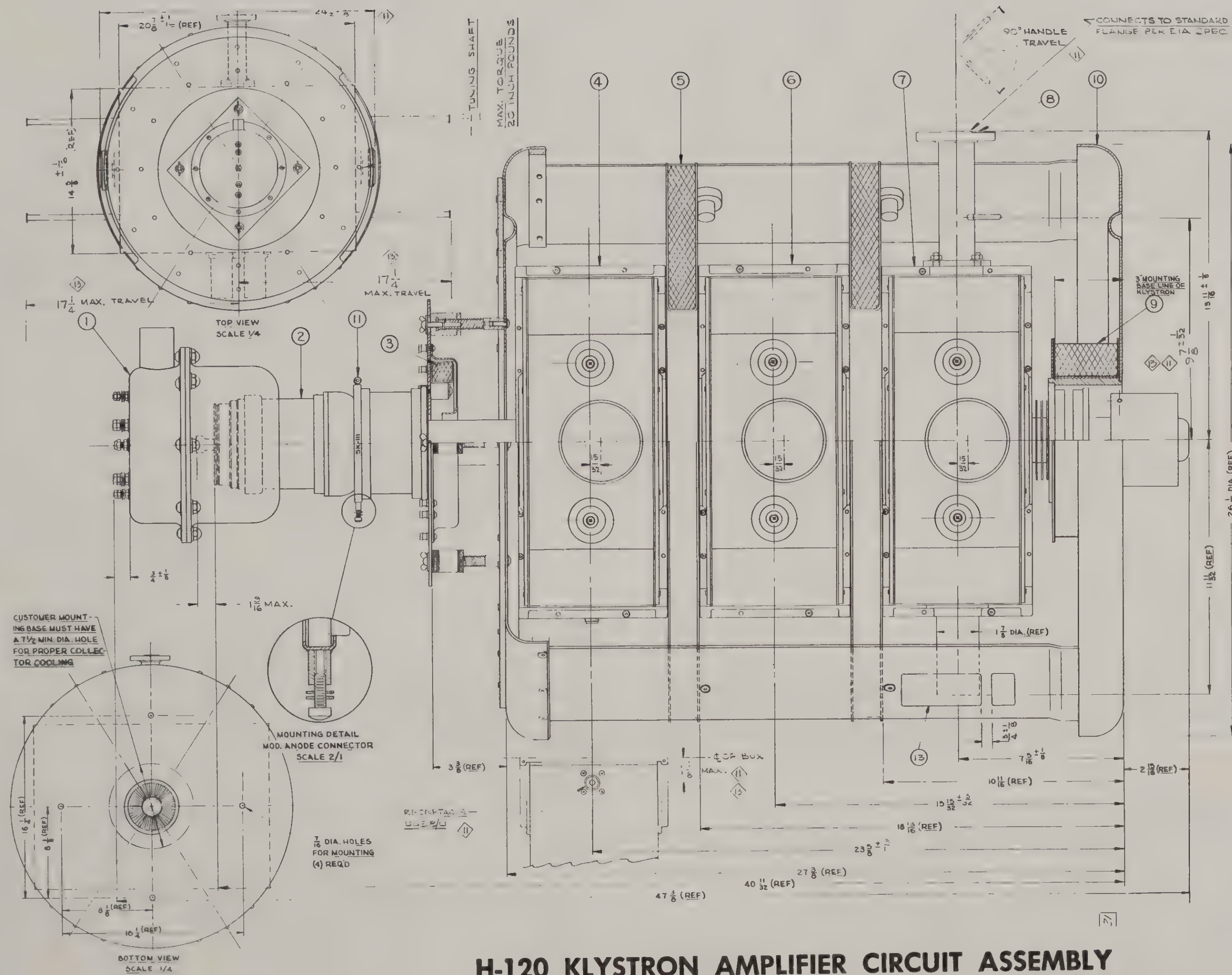


Nº	PART Nº	DESCRIPTION	REQ.
1	000119	SK-100 SOCKET	1
2	3KM3000LA6000	3KM3000LA KLYSTRON	REF.
3	116012	MC-201 PRE-FOCUS COIL	1
4	117277	RF-411 INPUT TUNING BOX	2
5	127217	MC-294 BODY COIL ASSY	2
6	127196	PREFOCUS CONTROL	1
7	117467	RF-444 OUTPUT TUNING BOX	1
8	121412	LC-513A OUTPUT LOAD COUPLER	1
9	127201	MC-295 COLLECTOR COIL	1
10	127212	MF-164 MAGNETIC FRAME	1
11	115454	SK-111 MOD. ANODE CONNECTOR	1
* 12	120253	HT-100 WRENCH	1
13	126003N	LARGE NAMEPLATE	1
14	127148 MOD.	COIL CENTERING PAD	3
15			

* ITEM NOT SHOWN ON DRAWING.

NOTE.
1. TUNERS MAY BE ABOVE OR BELOW CENTERLINE EXCEPT IN OUTPUT CAVITY WHERE PLATE ONLY IS TO BE ROTATED 180° TO OBTAIN DESIRED TUNER LOCATION.

H-205 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY



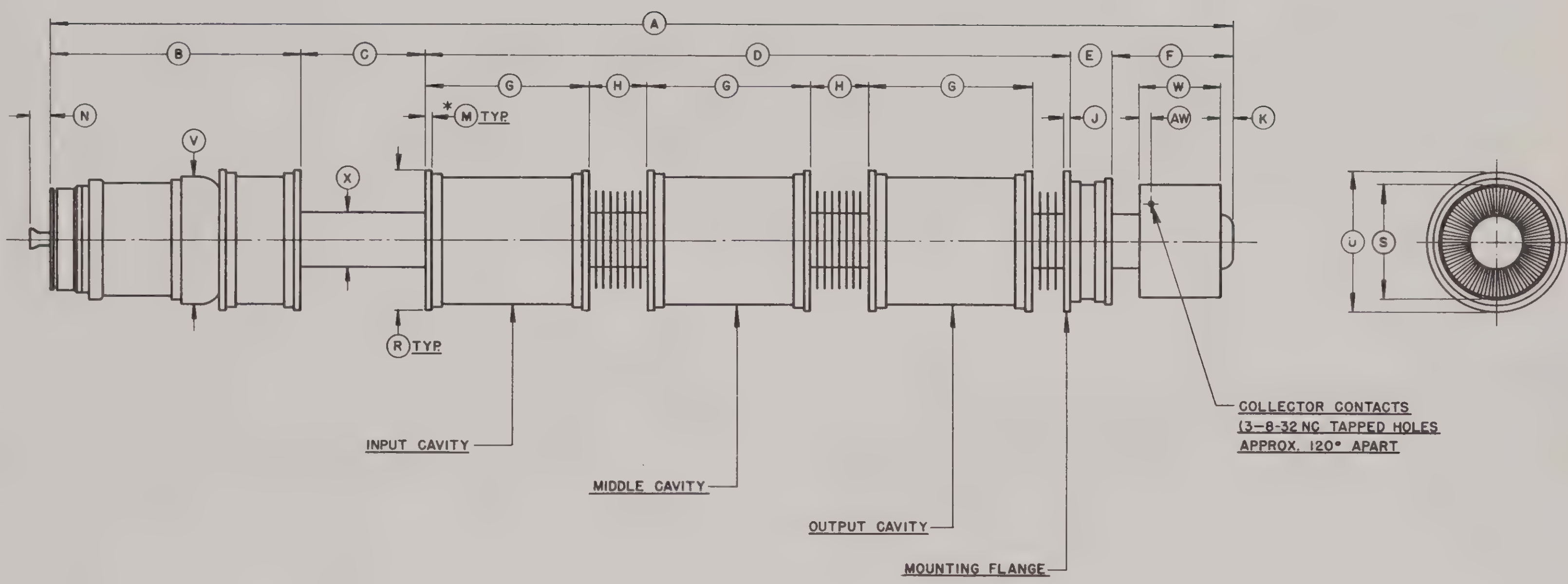
Nº	PART Nº	DESCRIPTION	REQ
1	000119	SK-100 SOCKET	1
2	3KM3000LA6000	3KM3000LA KLYSTRON	REF.
3	116012	MC-201 PRE-FOCUS COIL	1
4	117277	RF-411 INPUT TUNING BOX	1
5	116084	MC-212 BODY COIL	2
6	117466	RF-443 MIDDLE TUNING BOX	1
7	117467	RF-444 OUTPUT TUNING BOX	1
8	121412	LC-313A OUTPUT LOAD COUPLER	1
9	116015	MC-203 COLLECTOR COIL	1
10	120235	MF-115 MAGNETIC FRAME	1
11	115454	SK-111 MOD. ANODE CONNECTOR	1
* 12	121253	HT-100 WRENCH	1
13	126003N	LARGE NAME PLATE	1
14			
15			

* ITEM NOT SHOWN ON DRAWING.

NOTE.
1. TUNERS MAY BE ABOVE OR BELOW CENTERLINE EXCEPT IN OUTPUT CAVITY WHERE PLATE ONLY IS TO BE ROTATED 180° TO OBTAIN DESIRED TUNER LOCATION.

H-120 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		42.895	43.485
B		9.125	9.330
C		4.450	4.520
D		23.500	23.700
E		1.480	1.540
F		4.340	4.450
G		5.995	6.030
H		2.085	2.155
J		.235	.260
K			.435
M		.187	.260
N			1.500
R		5.118	5.132
S		4.110	4.140
U		5.118	5.132
V		4.615	4.650
W		2.950	3.125
X		1.990	2.010
AW		.340	.505



3KM3000LA KLYSTRON

NOTES:

1. DIMENSIONS IN INCHES.
2. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE OUTLINE GUN NO. 1-6001
3. * MINIMUM CONTACT SURFACES.

EIMAC

A Division of Varian Associates

4KM150LA

50KW
POWER-AMPLIFIER
L-BAND KLYSTRON

The Eimac 4KM150LA is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 470 to 610 megacycles. Intended primarily for television visual service, it is also suitable for aural TV, or for tropospheric-scatter communications service.

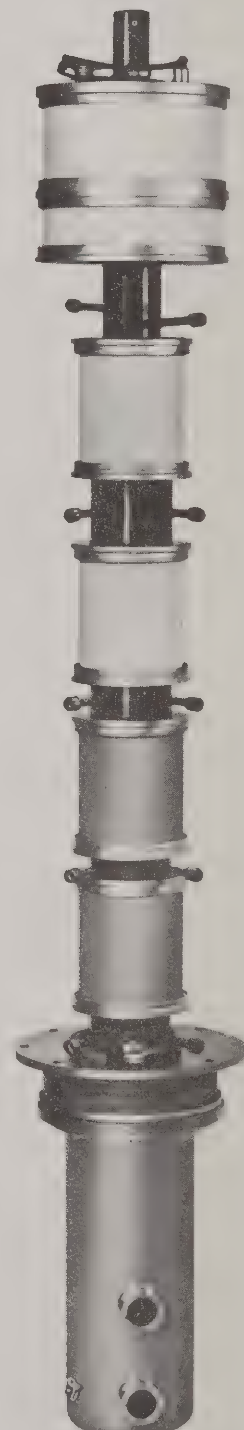
In television visual service, the 4KM150LA will provide more than 50 kilowatts of peak synchronizing power, with a power gain of 30 decibels, and 1 db bandwidth of 8 megacycles. Random AM noise is more than 60 db below black level.

The electron gun of this klystron utilizes a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. The cathode loading of only 150 milliamperes per square centimeter, at a beam voltage of 22 kilovolts, is conservative in the interest of long life. Effective protection from internal arcs is provided by the Eimac Modulating Anode.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. Load couplers are provided to permit external loading of these cavities for extreme wideband operation.

The 4KM150LA incorporates a built-in vacuum pump in the form of a titanium getter. This getter should be energized whenever heater power is applied. Its normal operating voltage is 3.7 volts at approximately 20 amperes.

Eimac Klystron Amplifier Circuit Assembly H-163 has been designed for use with the 4KM150LA to cover the specified frequency range. This assembly includes a klystron supporting structure, focusing electromagnet, tuning cavities, and adjustable load couplers for each cavity.



CHARACTERISTICS

ELECTRICAL

Heater:	DC Voltage	26.0	volts
	DC Current	11.5	amperes
	Maximum Starting Current	23	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	AC Voltage ($\pm5\%$)	3.7	volts
	AC Current	20	amperes

ELECTRICAL (continued):

Power Gain:	Television Visual Service	30	decibels
Output Power:	Television Visual Service	50	kilowatts
Frequency Range	(H-163 Assembly)	470 to 610	megacycles

MECHANICAL

Operating Position. . . . . .Axis vertical, cathode up

RF Coupling:

- Input. . . . . .Type "N" coaxial fitting
- Output . . . . .3-1/8 inch, 50-ohm line
- Input and 2nd Cavity Loading . . . . .Type "N" coaxial fitting
- 3rd Cavity Loading . . . . 1-5/8 inch, 50-ohm line

Approximate Weights:

Klystron Only	119	pounds
H-163 RF Circuit Assembly	1800	pounds

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	*5 cfm	------
Cavity	50 cfm	TBS
Klystron Body and Electromagnet in Series	2 gpm	45 psi
Klystron Collector	45 gpm	35 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	0 to 250	volts
Current	0 to 15	amperes

MAXIMUM RATINGS

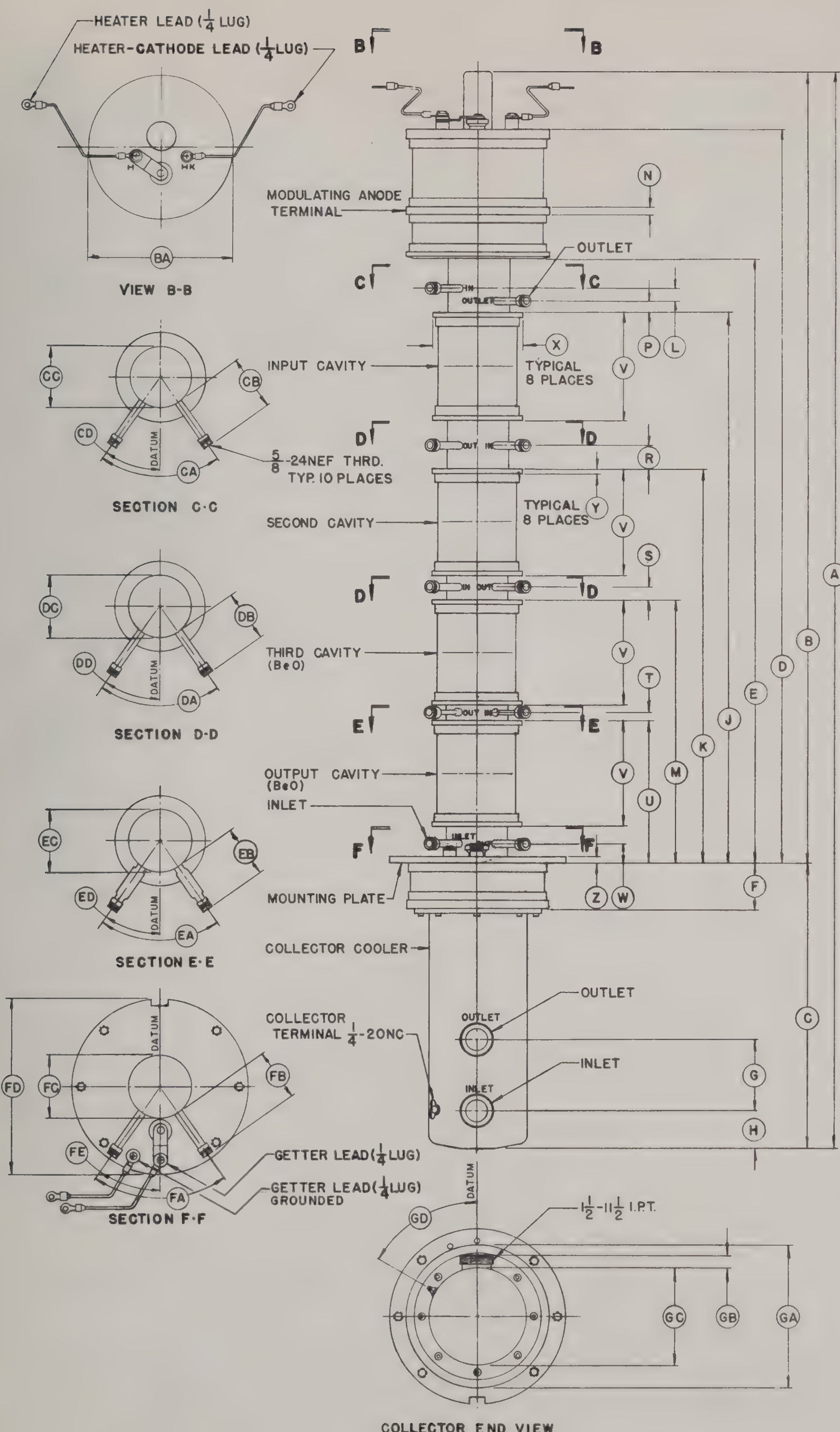
DC BEAM VOLTAGE	23	KILOVOLTS
DC BEAM CURRENT	7.0	AMPERES
DC BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	150	KILOWATTS
INLET WATER PRESSURE	100	PSI

TYPICAL OPERATION

	TV Visual Amplifier	
Frequency	550	megacycles
Output Power	55 (peak sync)	kilowatts
Driving Power	20 " "	watts
Power Gain	34.4 " "	decibels
DC Beam Voltage	22	kilovolts
DC Beam Current	6.3	amperes
Beam Power Efficiency	39.5 (peak sync)	percent
1 db Bandwidth	8	megacycles
Electromagnet Current	10	amperes

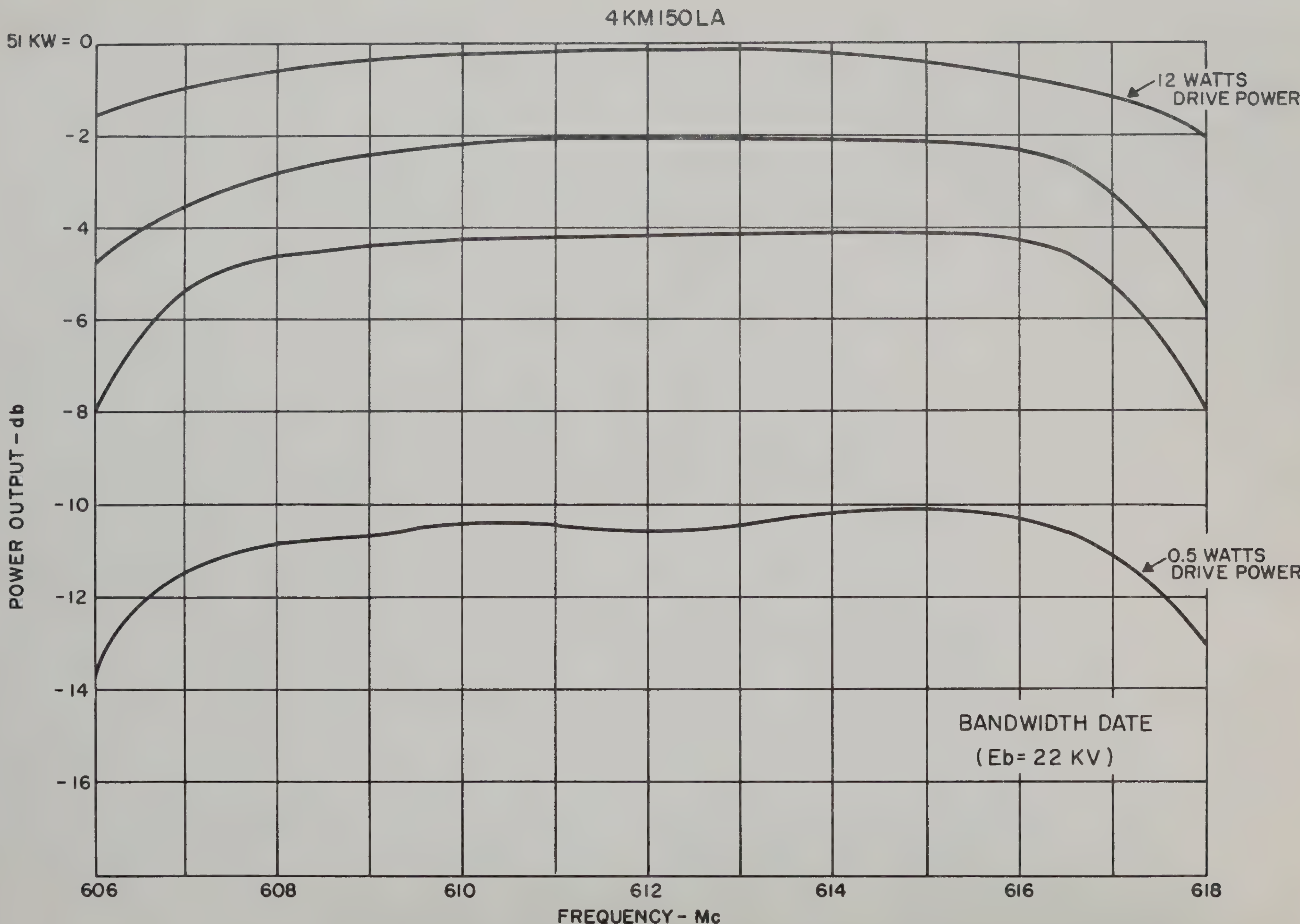
* Required only if ambient air temperature exceeds 25° C.

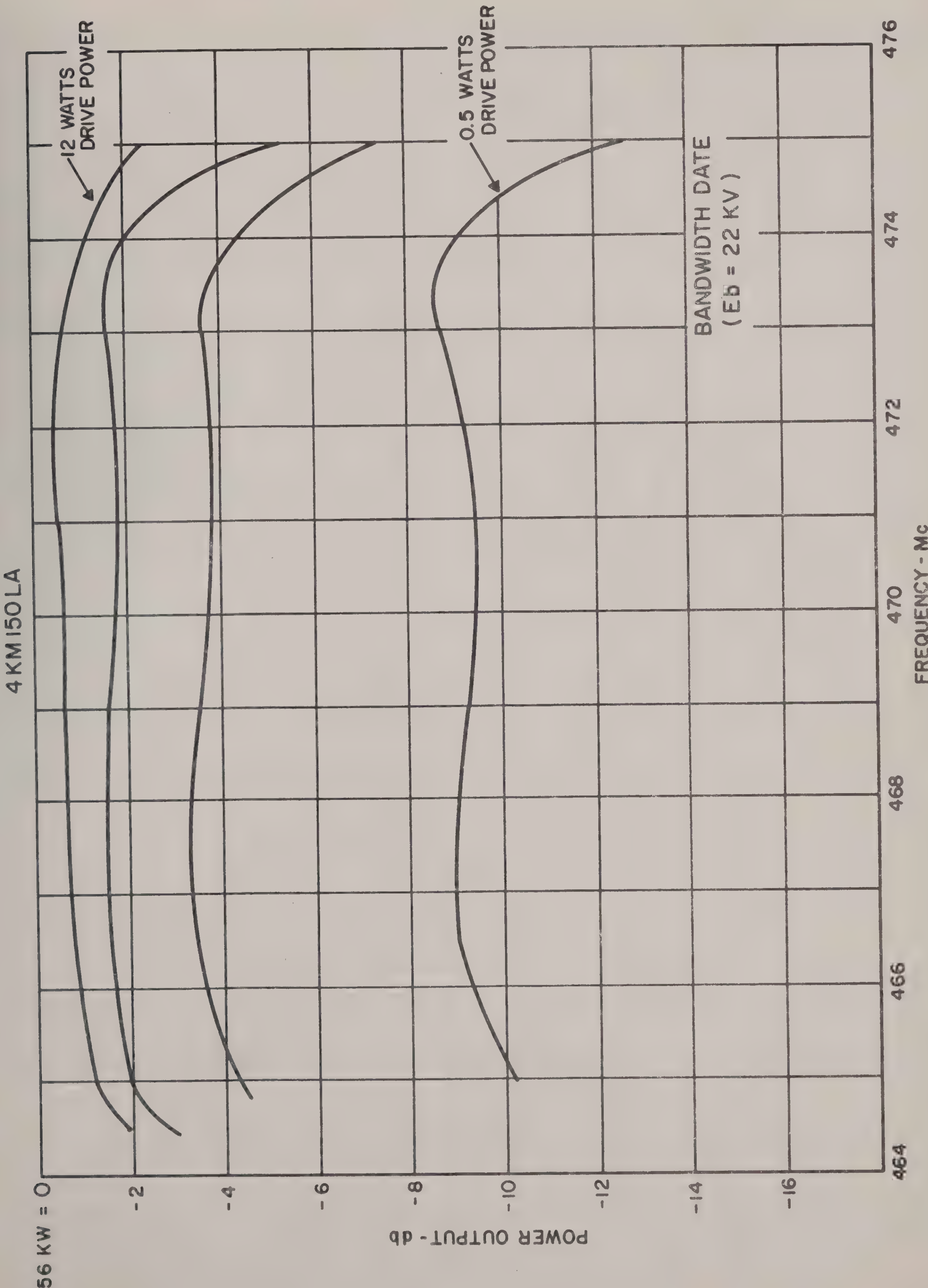
For additional information or for information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

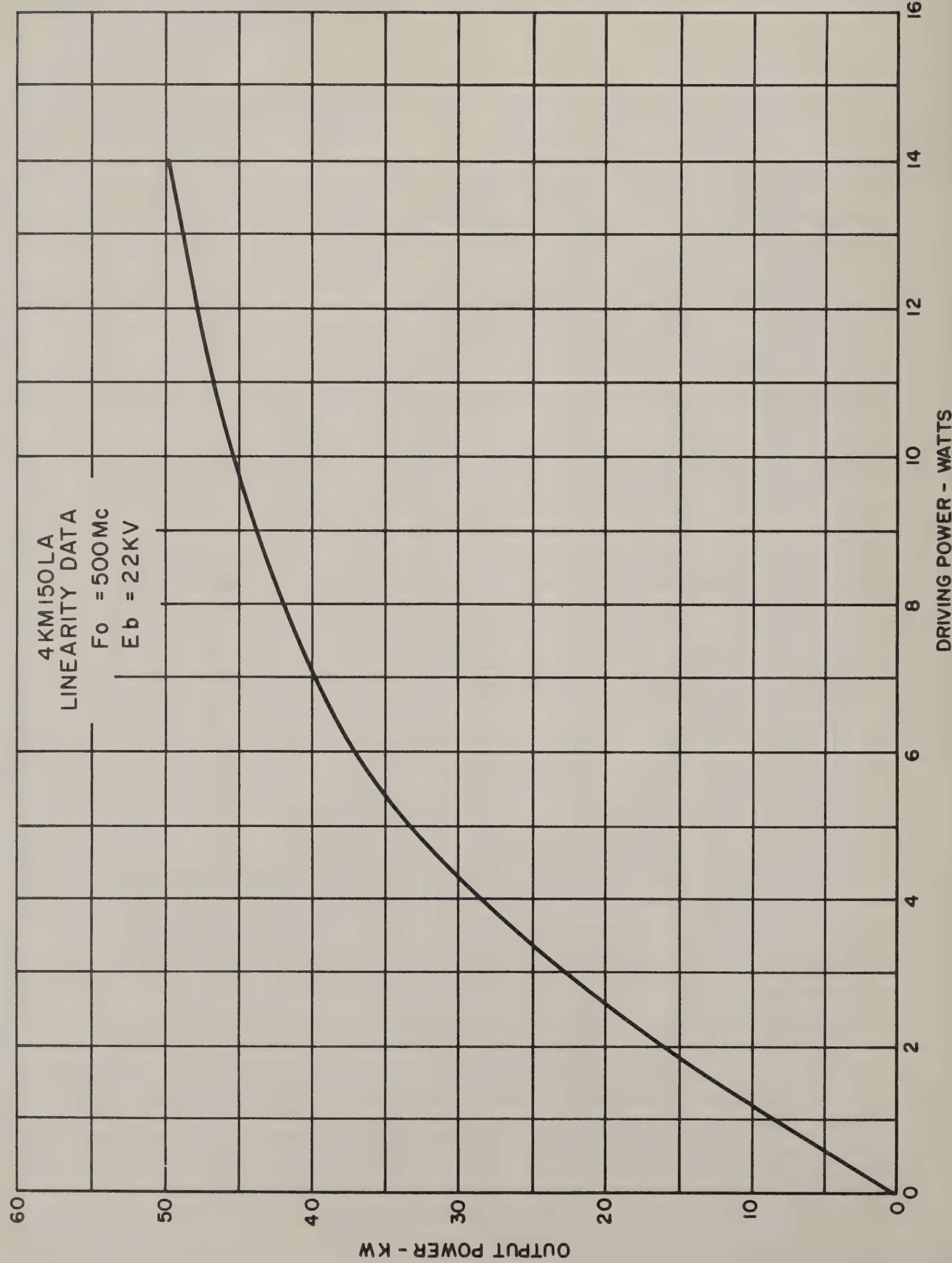


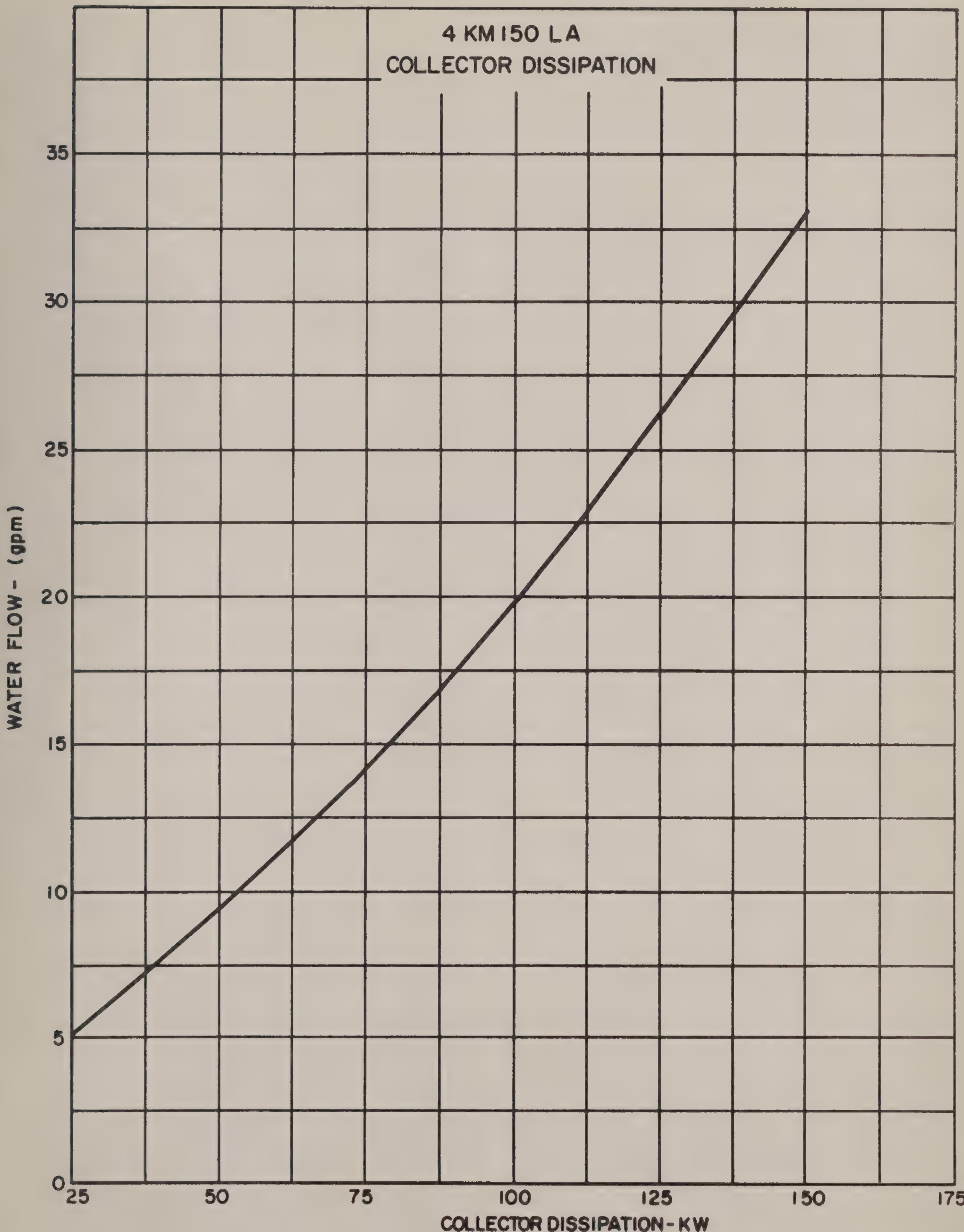
DIMENSION DATA			
REF.	NOMINAL	MINIMUM	MAXIMUM
A	61.625		
B	45.150		
C	16.475		
D	41.900		
E	34.467		
F	2.600		
G	4.000		
H	2.125		
J	31.341		
K	22.499		
L	.625		
M	14.999		
N	.375		
P	.636		
R	1.433		
S	.875		
T	.453		
U	8.124		
V	6.000		
W	1.124		
X	5.125		
Y	.250		
Z	.375		
BA	8.125 DIA		
CA	70°		
CB	3.000		
CC	3.500 DIA		
CD	35°		
DA	70°		
DB	3.000		
DC	3.500 DIA		
DD	35°		
EA	70°		
EB	3.000		
EC	3.500 DIA		
ED	35°		
FA	70°		
FB	3.000		
FC	3.500 DIA		
FD	10.000 DIA		
FE	35°		
GA	8.125 DIA		
GB	.843		
GC	5.500 DIA		
GD	60°		

4KM150LA KLYSTRON

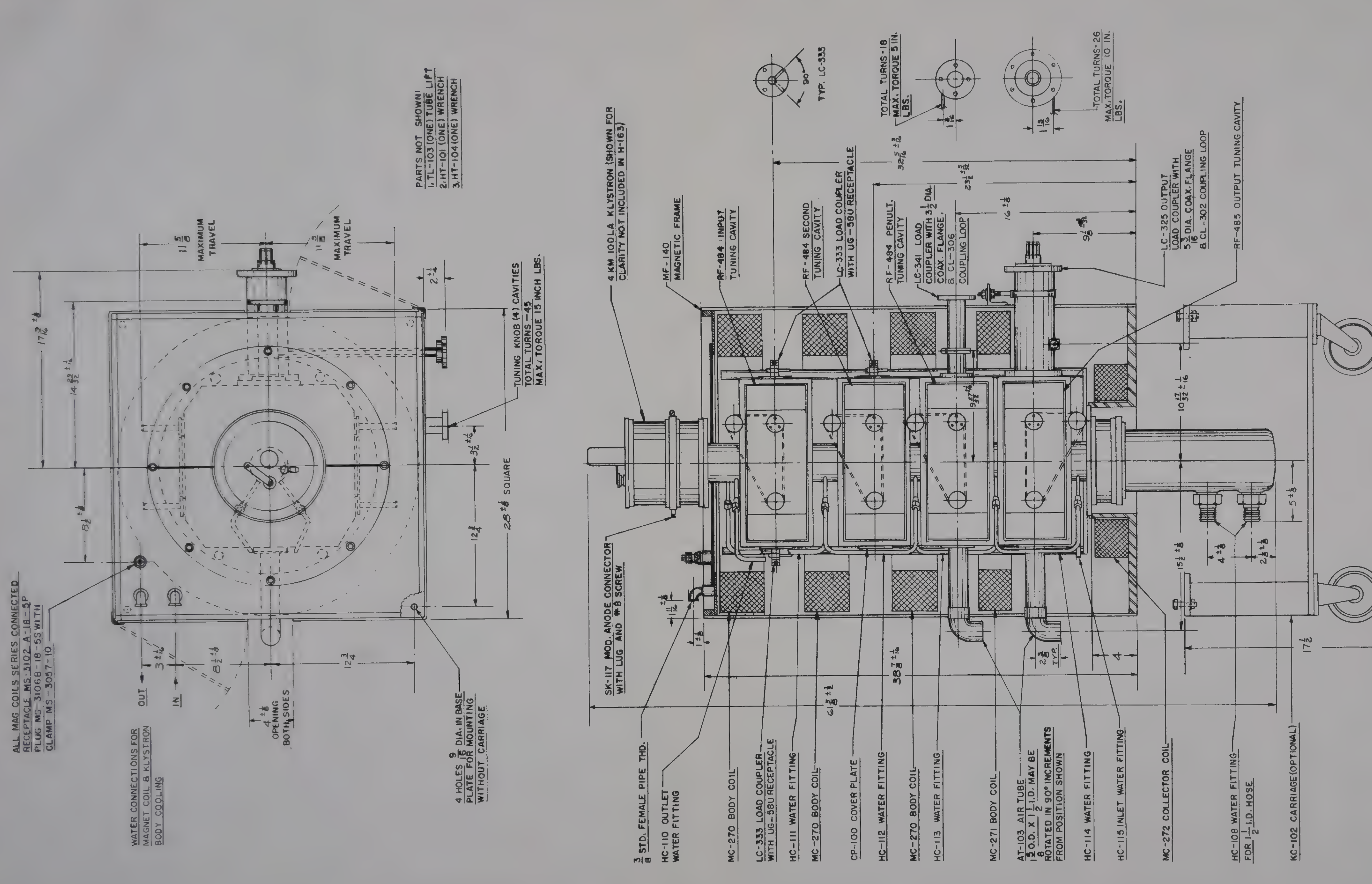

4KM150LA
51 KW = 0
-2
-4
-6
-8
-10
-12
-14
-16
POWER OUTPUT - db
606
608
610
612
614
616
618
FREQUENCY - Mc
12 WATTS DRIVE POWER
0.5 WATTS DRIVE POWER
BANDWIDTH DATE
(Eb= 22 KV)


4KM150LA
12 WATTS DRIVE POWER
0.5 WATTS DRIVE POWER
BANDWIDTH DATE
(Eb = 22 KV)
56 KW = 0
-2
-4
-6
-8
-10
-12
-14
-16
POWER OUTPUT - db
464
466
468
470
472
474
476
FREQUENCY - Mc


4KM150LA
LINEARITY DATA
Fo = 500Mc
Eb = 22KV
DRIVING POWER - WATTS
0
2
4
6
8
10
12
14
16
OUTPUT POWER - KW
0
10
20
30
40
50
60


4 KM150 LA
COLLECTOR DISSIPATION
WATER FLOW - (gpm)
0
5
10
15
20
25
30
35
25
50
75
100
125
150
175
COLLECTOR DISSIPATION - KW

4KM150LA



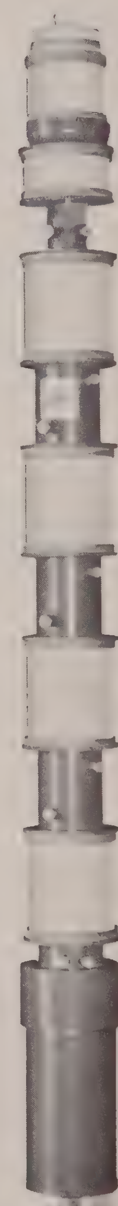
H-163 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

Eimac®

EITEL-McCULLOUGH, INC.

4KM50,000LA5

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM50,000LA5 is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 400 and 610 megacycles. This klystron will deliver a narrow-band CW output power of 10 kilowatts with a minimum power gain of 50 decibels. When adjusted for wideband operation the 4KM50,000LA5 will deliver an output power of 10 kilowatts with a half-power bandwidth of 3 megacycles and a power gain of 40 decibels.

The 4KM50,000LA5 employs the Eimac Modulating Anode which provides an effective means of protecting the tube from internal arcs.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-206 has been designed for use with the 4KM50,000LA5 to cover the specified frequency range. This assembly includes a klystron supporting structure, focusing coils, tuning cavities, adjustable load couplers for the cavities and an Eimac SK-110 Air System Socket. The H-206 Circuit Assembly is suitable for use in either fixed station, van mounted or shipboard installations.

CHARACTERISTICS

ELECTRICAL

Heater: Voltage	7.5 (±5%) volts
Current (nominal)	20 amperes
Cathode: EMA, Unipotential	
Heating Time	5 minutes
Getter (Operating):	
Voltage	2.0 volts
Current	36.0 amperes
Power Gain: (Narrow Band)	50 decibels
Output Power	10 kilowatts
Frequency Range (H-206 Assembly)	400 to 610 megacycles

MECHANICAL

Operating Position		Axis vertical, cathode up
Coupling (rf):		
Input		Type "N" coaxial fitting
Output		3⅛ inch, 50-ohm line
Input, 2nd and 3rd Cavity Loading		Type "N" coaxial fitting
Weights:		
4KM50,000LA5 Klystron		74 lbs
H-206 Circuit Assembly		775 lbs

Cooling: Water and Forced Air	*Flow Rate*	*Pressure Drop*
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series)	1 gpm	28 psi
Klystron Collector	25 gpm	28 psi

FOCUS-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil: Voltage	0 to 50	volts
Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:		
Voltage	0 to 500	volts
Current	0 to 2.75	amperes

MAXIMUM RATINGS

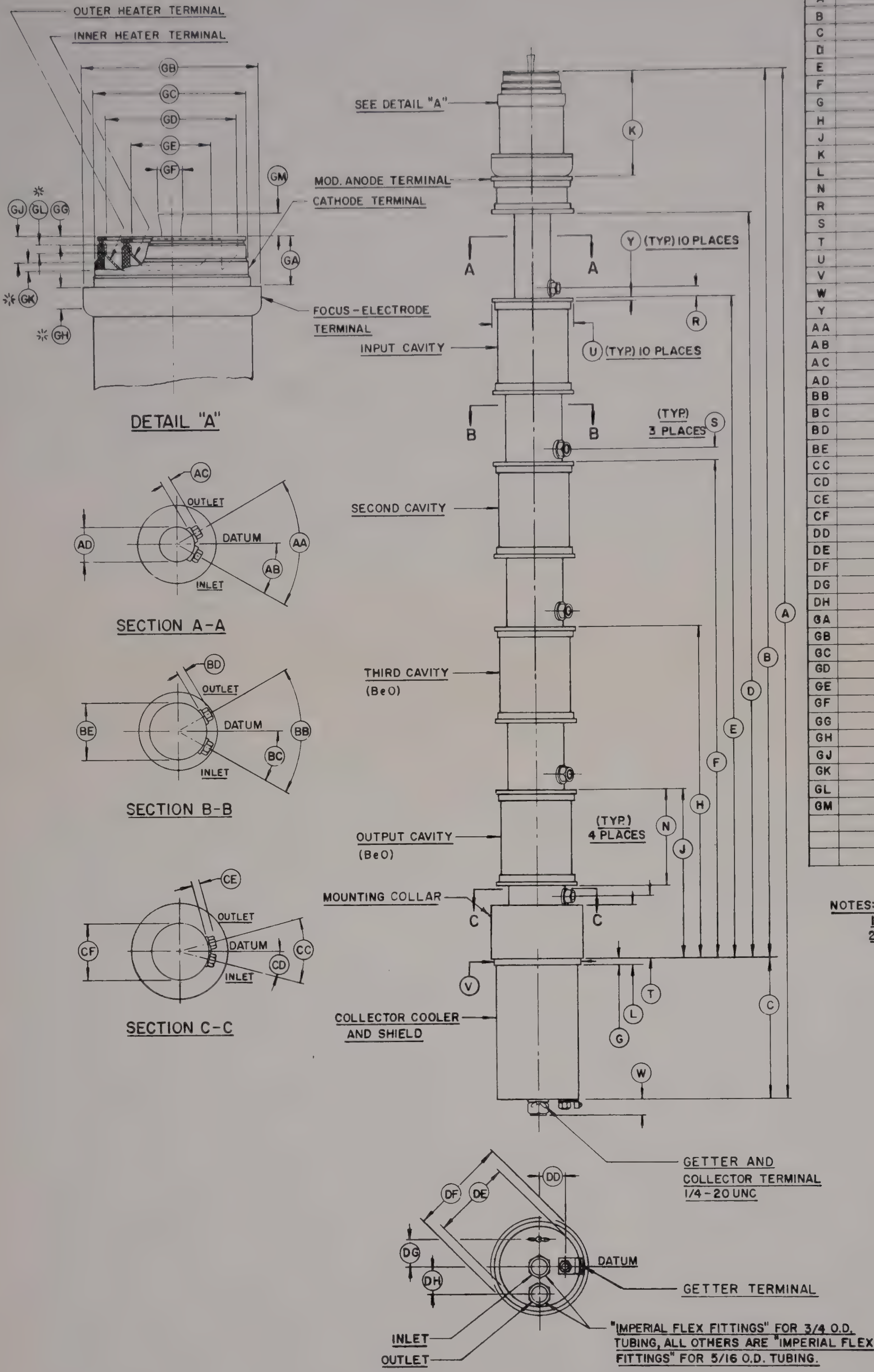
BEAM CURRENT (dc)	20	KILOVOLTS
BEAM VOLTAGE (dc)	2.5	AMPERES
BODY CURRENT (dc)	100	MILLIAMPERES
GETTER CURRENT (ac)	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	—500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS
INLET WATER PRESSURE	70	PSIG

TYPICAL OPERATION

	Narrow Band		*Wide Band*	
Frequency	400	610	456	megacycles
Output Power	13.1	12.0	11.0	kilowatts
Driving Power	0.05	0.05	0.5	watt
Power Gain	54	53.8	43.8	decibels
Beam Voltage	17	17	17	kilovolts dc
Beam Current	1.8	1.8	2.04	amperes dc
Beam Power Efficiency	42.8	39.2	32.5	percent
Body Current	90	80	75	milliamperes dc
Input Cavity Loading	0	0	0.4	watt
Second Cavity Loading	0	0	13	watts
Penultimate Cavity Loading	0	0	200	watts
Bandwidth (3db)	0.3	0.5	3.5	megacycles
Focus-Electrode Voltage	—201	—211	—100	volts
Focus-Coil Currents (H-206 Components):				
Prefocus Coil	1.0	0.97	1.3	amperes
Three Body Coils and Collector Coil in Series	2.0	2.0	2.6	amperes

*At sea level with 20°C inlet air temperature.

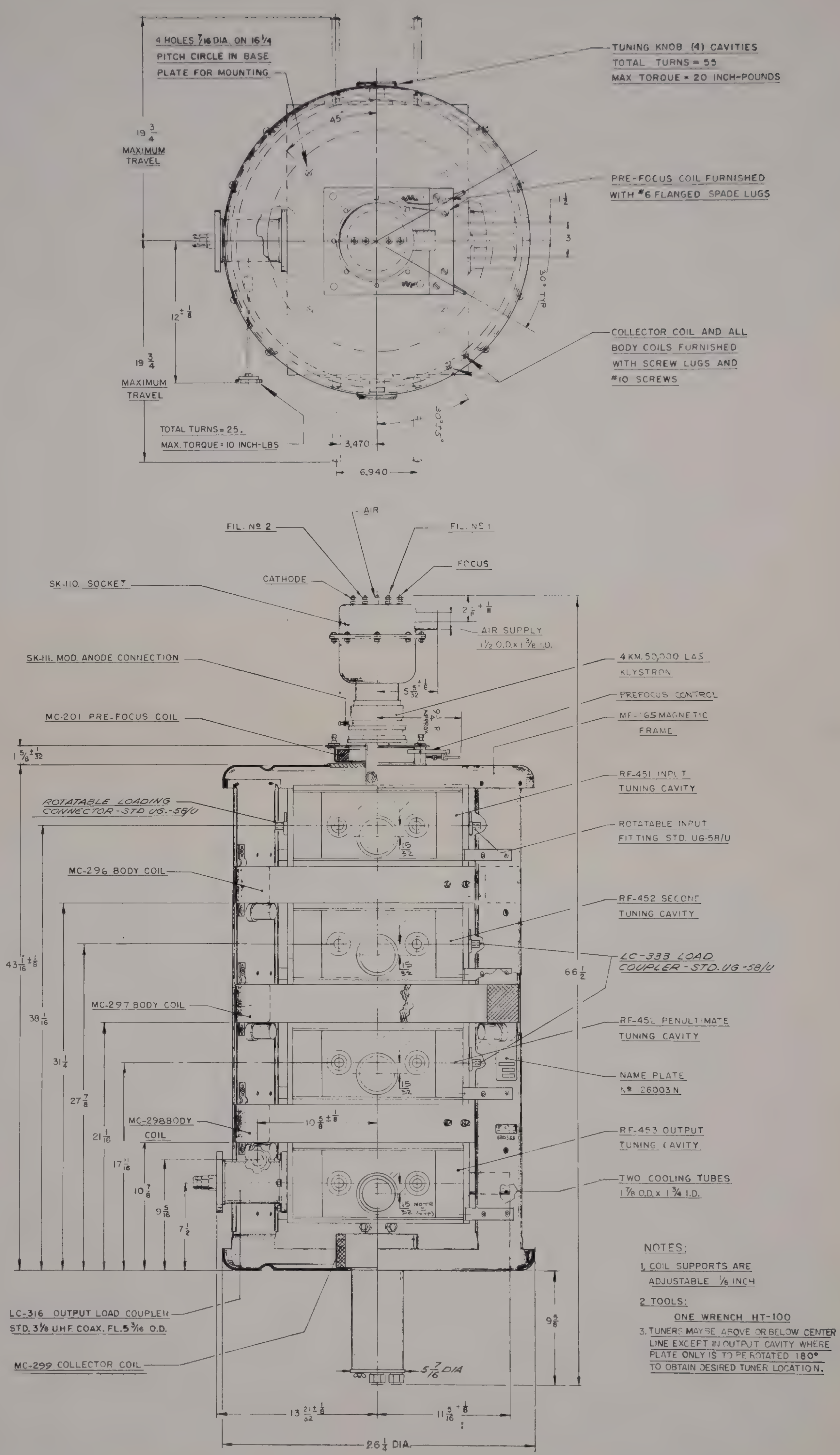
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.



DIMENSIONAL DATA			
REF	NOM	MIN.	MAX.
A		60.945	61.945
B		52.450	52.950
C		8.495	8.995
D		43.225	43.625
E		40.725	41.025
F		30.605	30.775
G		.120	.130
H		20.475	20.595
J		10.305	10.405
K		6.000	6.350
L		3.240	3.260
N		5.950	6.025
R		.840	1.100
S		.840	
T		3.505	3.610
U		5.105	5.145
V		5.115	5.130
W		1.000	1.100
Y		.230	.270
AA		55°	65°
AB		25°	35°
AC		.750	.900
AD		2.100	2.150
BB		55°	65°
BC		25°	35°
BD		.750	.900
BE		3.480	3.520
CC		25°	35°
CD		10°	20°
CE		.750	.900
CF		3.480	3.520
DD		1.500	1.750
DE			4.875
DF		5.421	5.453
DG		1.500	1.750
DH		1.500	1.750
GA		1.000	1.500
GB		4.300	4.450
GC		3.750	3.835
GD		3.100	3.200
GE		1.865	1.950
GF			1.188
GG		.125	.175
GH		.500	
GJ		.670	.775
GK		.100	
GL		.100	
GM			1.500

NOTES:
1. ALL DIMENSIONS ARE IN INCHES.
2. * MINIMUM STRAIGHT SURFACE FOR CONTACT.

4KM50,000LA5 KLYSTRON



H-206 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

Tentative Data

5K50CB

10 KW CW
POWER AMPLIFIER
C-BAND KLYSTRON

EIMAC
A Division of Varian Associates

The Eimac 5K50CB power-amplifier klystron operates at frequencies from 4.4-5.0 kilomegacycles with a rated output power of 10 kilowatts and a minimum gain of 60 decibels. This klystron is intended primarily for use in tropospheric scatter communications systems.

A confined flow configuration is used in the electron gun of the 5K50CB to minimize focusing adjustments and to provide a thoroughly stable beam.

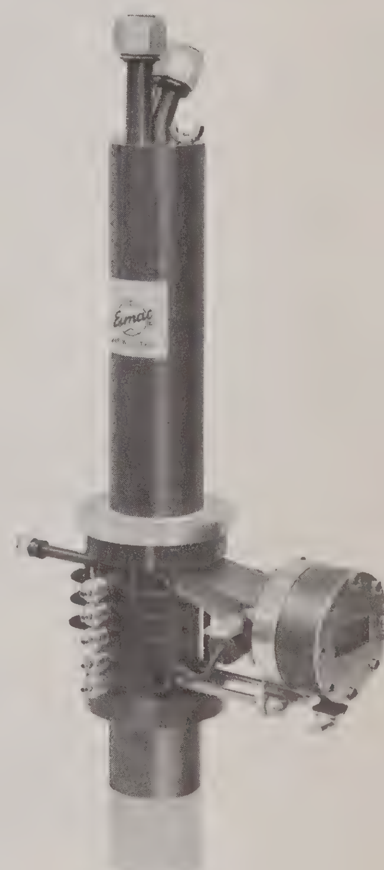
This electron gun is completely enclosed in a metal shield with integral shielded connecting leads to reduce the high voltage hazard to a minimum.

The small size and light weight of the 5K50CB make it suitable, where necessary, for mounting on the antenna structure of the system in which it is used.

Five integral cavities are used in the 5K50CB. Both input and output couplings are fixed. Unusual stability, for this power and frequency, is achieved through the use of improved body cooling.

The 5K50CB incorporates a built-in vacuum pump in the form of a titanium getter which should be energized whenever heater power is applied.

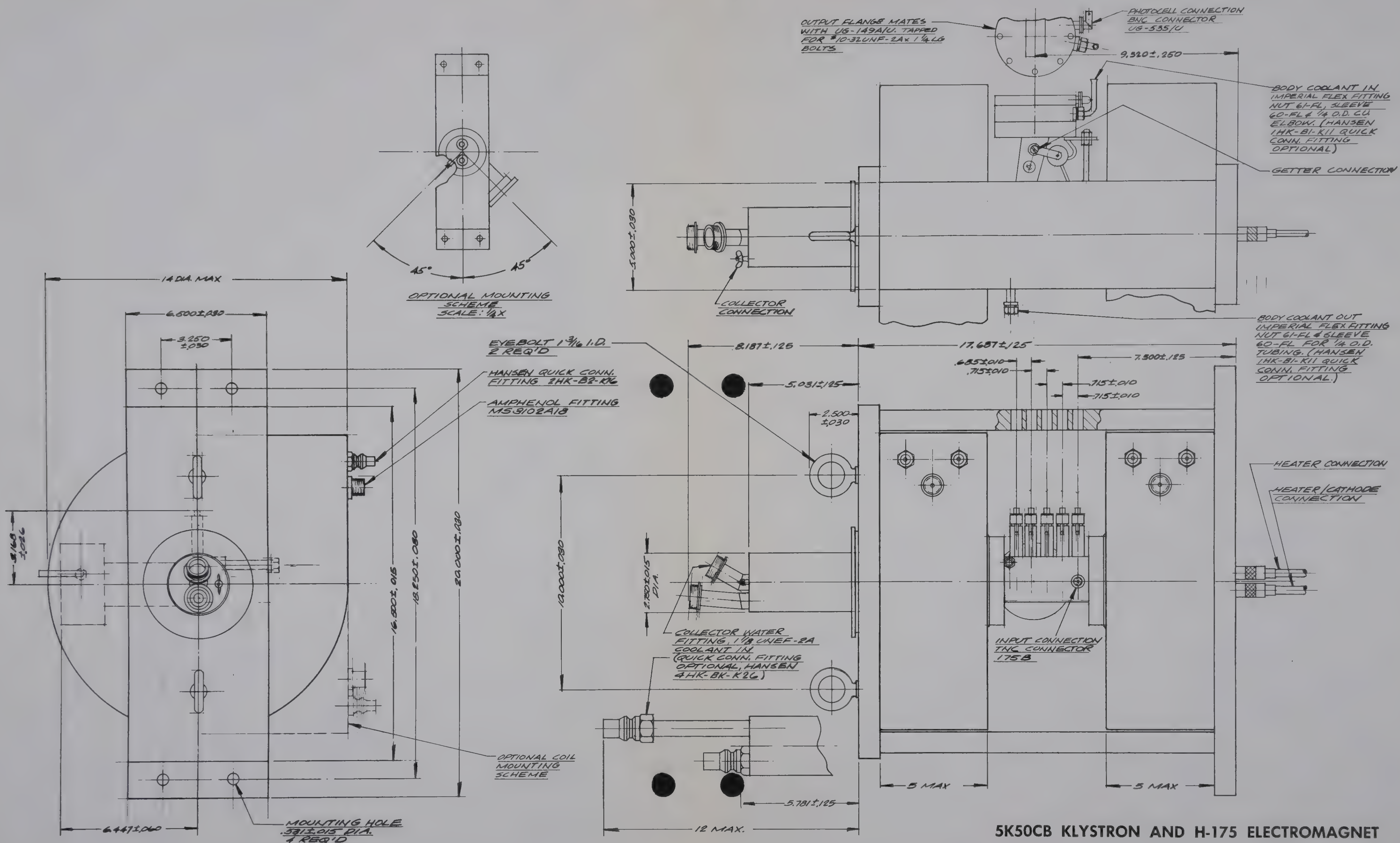
A focusing electromagnet and klystron supporting structure, Catalog Number H-175, has been designed for use with the 5K50CB.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage	10 volts
Current	3.0 amperes
Cathode: Impregnated, Unipotential	
Heating Time	5 minutes
Getter: Voltage	4.0 volts
Current	25 amperes
Power Gain	60 decibels
Output Power	10 kilowatts
Frequency Range	4.4-5.0 kilomegacycles
Phase sensitivity to beam voltage	0.06 degrees/volt



5K50CB KLYSTRON AND H-175 ELECTROMAGNET

MECHANICAL

Operating Position	Axis Vertical, Cathode Down
Output rf Coupling	RG49/U Waveguide
Input rf Coupling	TNC
Dimensions: Klystron only	6 x 7 x 26½ inches
Electromagnet:	
Height	18.5 inches
Width	15.5 inches
Depth	20 inches
Weight: Klystron only	30 lbs
Electromagnet	270 lbs

Cooling: 52.5/47.5 Solution, Ethylene Glycol and Water	*Flow Rate*	*Pressure Drop*
Body	1.5 gpm	50 psi
Collector	9 gpm	50 psi
Electromagnet	2 gpm	50 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	170 volts
Current	10 amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	17.5 KILOVOLTS
DC BEAM CURRENT	2.5 AMPERES
DC BEAM INPUT POWER	50 KILOWATTS
DC BODY CURRENT (with rf drive)	80 MILLIAMPERES
COLLECTOR DISSIPATION	50 KILOWATTS
INLET WATER PRESSURE	120 PSI
OUTLET WATER TEMPERATURE	80 DEGREES C
LOAD VSWR	1.2:1

TYPICAL OPERATION — TUNED FOR HIGH EFFICIENCY

Frequency	4700 megacycles
Output Power	10 kilowatts
Driving Power	10 milliwatts
Power Gain	60 decibels
DC Beam Voltage	15 kilovolts
DC Beam Current	2.0 amperes
Beam Power Efficiency	33 percent
DC Body Current	40 milliamperes
3 db Bandwidth	15 megacycles
Electromagnet Current	9.5 amperes

For additional information or information regarding a specific application, write to Eimac Division, Varian Associates, 301 Industrial Way, San Carlos, California

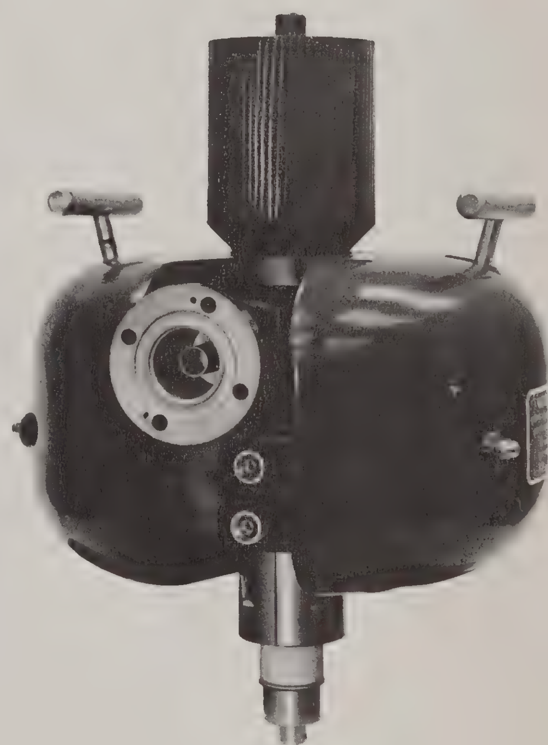
EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4K3SK

POWER AMPLIFIER
S-BAND KLYSTRON

The Eimac 4K3SK is an air cooled, permanent magnet focused, power amplifier klystron designed to operate at frequencies from 2400 to 2700 megacycles. It will deliver a minimum output power of 1 kilowatt with a minimum power gain of 40 decibels. The 4K3SK is intended for use in applications where light weight and compactness are essential.



FEATURES

FREQUENCY - - - - - - - - - -	2400-2700 Mc
MINIMUM OUTPUT POWER - - - - -	1 kW
MINIMUM POWER GAIN - - - - - -	40 db
HALF POWER BANDWIDTH - - - - -	10 Mc

PERMANENT MAGNET FOCUSING
FOUR INTEGRAL CAVITIES
LOW NOISE LEVEL
FIXED INPUT AND OUTPUT COUPLING
PROVISION FOR SECOND CAVITY LOADING
TWO LIFTING HANDLES FOR EASE OF HANDLING
INSTANT FAULT RECYCLING

CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential

Starting Time -	3	minutes
Heater: Voltage - - - - - - - - - - - - - - - - - - -	6	volts
Current - - - - - - - - - - - - - - - - - - -	4.5	amperes

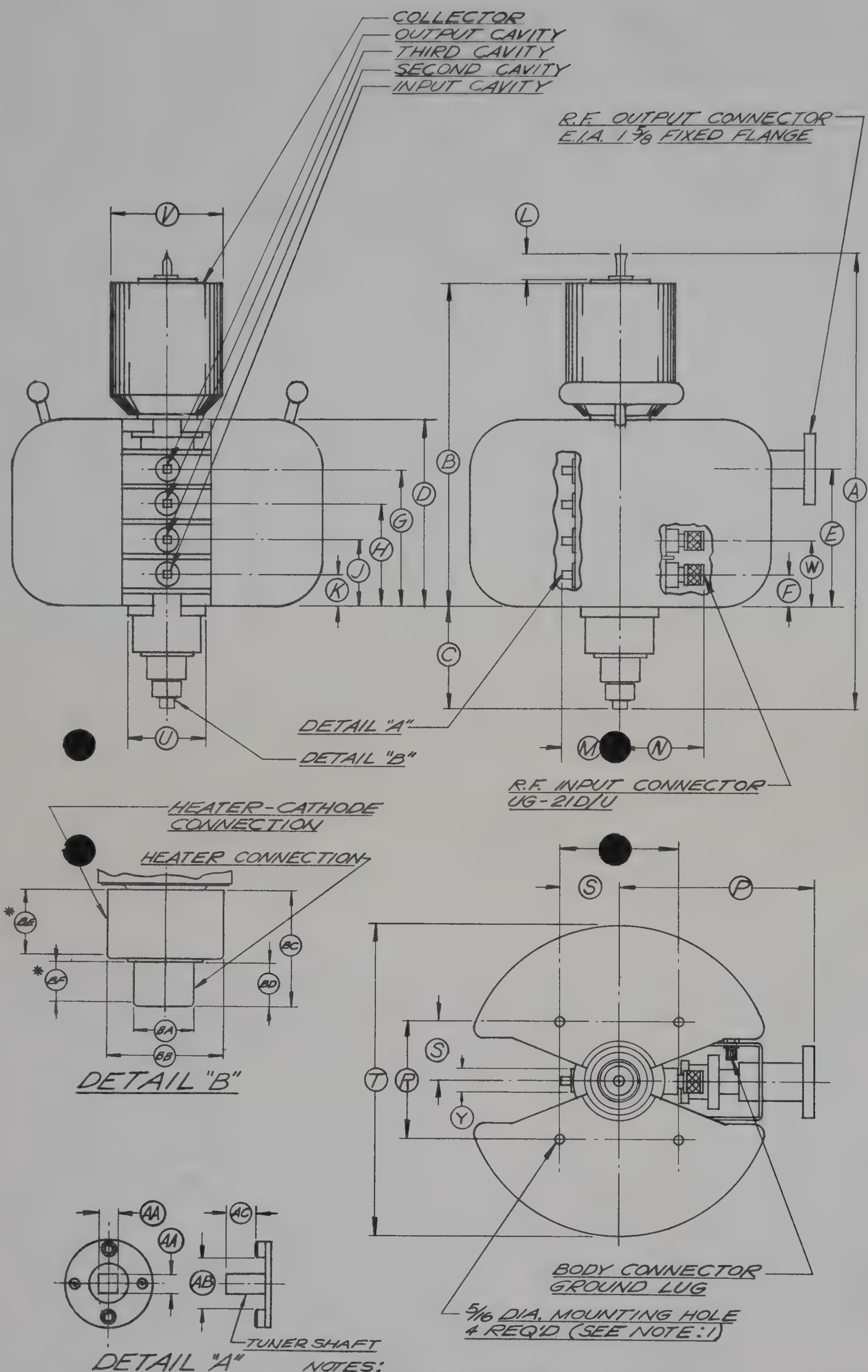
MECHANICAL

Operating Position (preferred) - - - - - - - - - - - - -	Vertical, cathode down
Tuner Starting Torque (maximum) - - - - - - - - - - - - -	12 inch pounds
Tuner Stop Torque (maximum) - - - - - - - - - - - - - -	25 inch pounds

Cooling: Forced Air (20°C at sea level)

Collector Flow - - - - - - - - - - - - - - - - - -	200	cfm
Collector Pressure Drop - - - - - - - - - - - - - -	1.75	inches H_2O

Body and Cathode seals require cooling only at higher temperatures or lower pressures.



DIMENSIONAL DATA			
REF	NOM.	MIN.	MAX.
A			19.000
B	13.475		
C	4.544		
D			7.874
E	5.820		
F	1.470		
G	5.820		
H	4.370		
J	2.920		
K	1.470		
L			.750
M	2.472		
N	3.475		
P	7.910		
R		4.888	5.012
S		2.444	2.506
T			13.196
U			3.042
V	4.383		
W	2.920		
Y		.900	
AA		.248	.252
AB		.647	
AC		.340	
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		.530	
BE		.830	
BF		.450	

NOTES:

1. KEEP MAGNETIC MATERIAL AT LEAST SIX INCHES AWAY FROM MAGNET; OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT SURFACES.
4. CYLINDER OF CLEARANCE TO BE CENTERED ON EACH TUNER SHAFT.

4K3SK KLYSTRON

MECHANICAL (continued)

Maximum Dimensions:	
Length	18.4 inches
Width	13.25 inches
Depth	14 inches
Input Coupling (rf)	UG-21 D/U Connector
Second Cavity Loading	UG-21 D/U Connector
Output Coupling (rf)	EIA 1-5/8 inch, 50-ohm coaxial
Weight (Klystron and Magnet)	85 pounds

MAXIMUM RATINGS

BEAM VOLTAGE (dc)	7	KILOVOLTS
BEAM CURRENT (dc)	0.6	AMPERE
BEAM INPUT POWER (dc)	4	KILOWATTS
COLLECTOR DISSIPATION	4	KILOWATTS
CATHODE SEAL TEMPERATURE	150	DEGREES C
LOAD VSWR	2:1	

TYPICAL OPERATION - TUNED FOR MAXIMUM EFFICIENCY

Frequency	2400	2550	2700	megacycles
Output Power	1.08	1.08	1.08	kilowatts
Driving Power	44	60	60	milliwatts
Gain	43.8	42.5	42.5	decibels
Second Cavity Loading	1	1	1.3	watt
Beam Voltage	6.5	6.5	6.5	kilovolts dc
Beam Current	0.58	0.58	0.58	ampere dc
3 db Bandwidth	10	12	15	megacycles

For additional information or information regarding a specific application, write to Eimac Division, Varian Associates, 301 Industrial Way, San Carlos, California

EIMAC

A Division of Varian Associates

EM1320

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

1000 - 2000 Mc

100 mw

DESCRIPTION

The EM1320 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 1000-2000 mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.

FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Flat Power Output
- Rugged

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	1000-2000 Mc
Anode Voltage	920-1840 V
Cathode Current	1-6 mA
Typical Power Output	200 mw
Anode FM Sensitivity	1 Mc/Volt
Injection Anode Voltage	200 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.9 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.5 lbs.

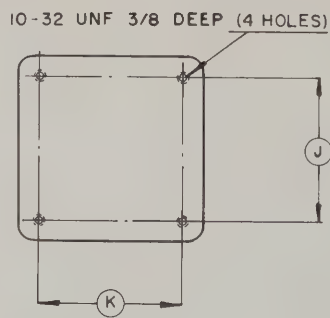
MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	12 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	1 mA
Load VSWR	3:1

*Damage to the tube may occur if maximum ratings are exceeded.

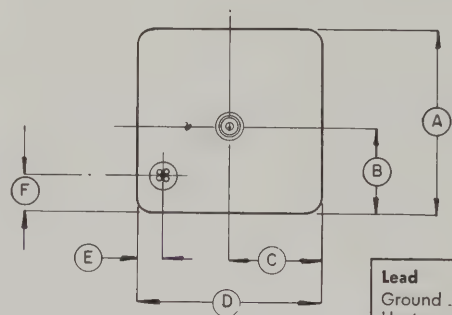
NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

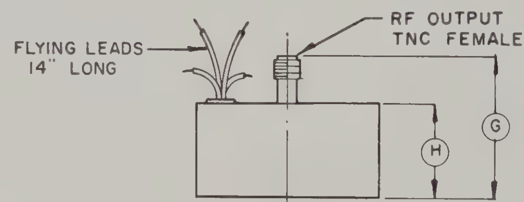


DIMENSIONS IN INCHES

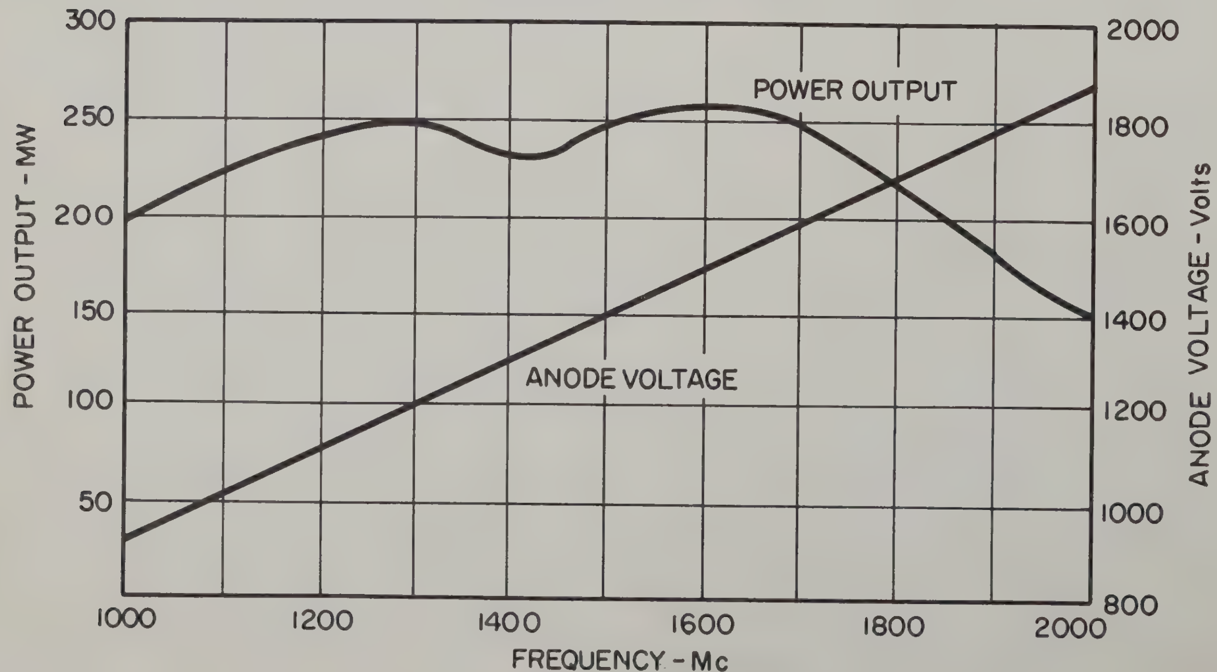
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	



Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White



CHARACTERISTIC CURVES
Typical Performance Values



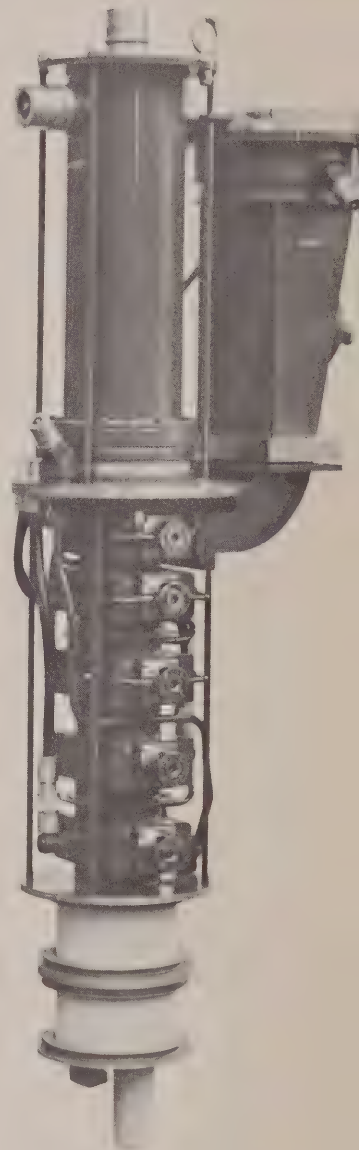
Tentative Data

5KM50SJ

S-BAND
10 KW CW

POWER AMPLIFIER
KLYSTRON

EITEL-McCULLOUGH, INC.



The Eimac 5KM50SJ power-amplifier klystron is intended primarily for use in the ground transmitters of satellite tracking systems. It operates at frequencies from 1700 to 2400 megacycles with an output power of 10 kilowatts. This tube is a member of Eimac's family of S-band klystrons, which also includes the 4KM70SJ, 4KM70SK, 5KM70SF, 5KM70SJ, 4KM-50SJ and 4KM50SK.

A large Eimac Matrix Type A cathode is used in the 5KM50SJ with cathode loading of less than 200 milliamperes per square centimeter. This light cathode loading for an S-band klystron assures long life. The electron gun has a confined flow configuration which minimizes focusing adjustments and produces a stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting rf output or body current. Only one electromagnet power supply is required.

Five integral cavities are used in the 5KM50SJ. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc which will withstand severe abuse. The second cavity of this klystron incorporates a coupling loop to which an external load must be connected.

The 5KM50SJ incorporates a built-in vacuum pump, in the form of a titanium getter, which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the Eimac Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-166, has been designed for use with the 5KM50SJ.

Eimac Water Load WL-201 is recommended for use with this klystron.

CHARACTERISTICS

ELECTRICAL

Heater: Voltage	7.5	volts
Current	12	amperes
Cathode: EMA, Unipotential Heating Time	5	minutes
Getter: AC Voltage (Nominal)	4	volts
AC Current	25	amperes
Power Gain	43	decibels
Output Power	10	kilowatts
Frequency Range	1700 to 2400	megacycles
Phase Shift as a function of beam voltage	0.068	degrees/volt

MECHANICAL

Operating Position	Any	
Coupling (rf):		
Input	Type N coaxial fitting	
Output	UG 435 A/U Flange	
Second Cavity Loading	Type N coaxial fitting	
Weight		
Klystron only	95	pounds
H-166 Electromagnet	205	pounds
Cooling: Water and Forced Air (25° C inlet temperature at sea level)	*Flow Rate*	*Pressure Drop*
Cathode	5 cfm	free
Klystron Body	1.2 gpm	50 psi
Klystron Collector	18 gpm	30 psi
Electromagnet	2 gpm	25 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage	0 to 150	volts
Current	0 to 20	amperes

MAXIMUM RATINGS

Beam Voltage (dc)	20	kilovolts
Beam Current (dc)	3	amperes
Beam Input Power (dc)	50	kilowatts
Body Current (dc)	75	milliamperes
Collector Dissipation	50	kilowatts
Inlet Water Pressure	80	psi
Load VSWR	1.5:1	
Coolant Outlet Temperature	70	degrees C

TYPICAL OPERATION — TUNED FOR MAXIMUM EFFICIENCY

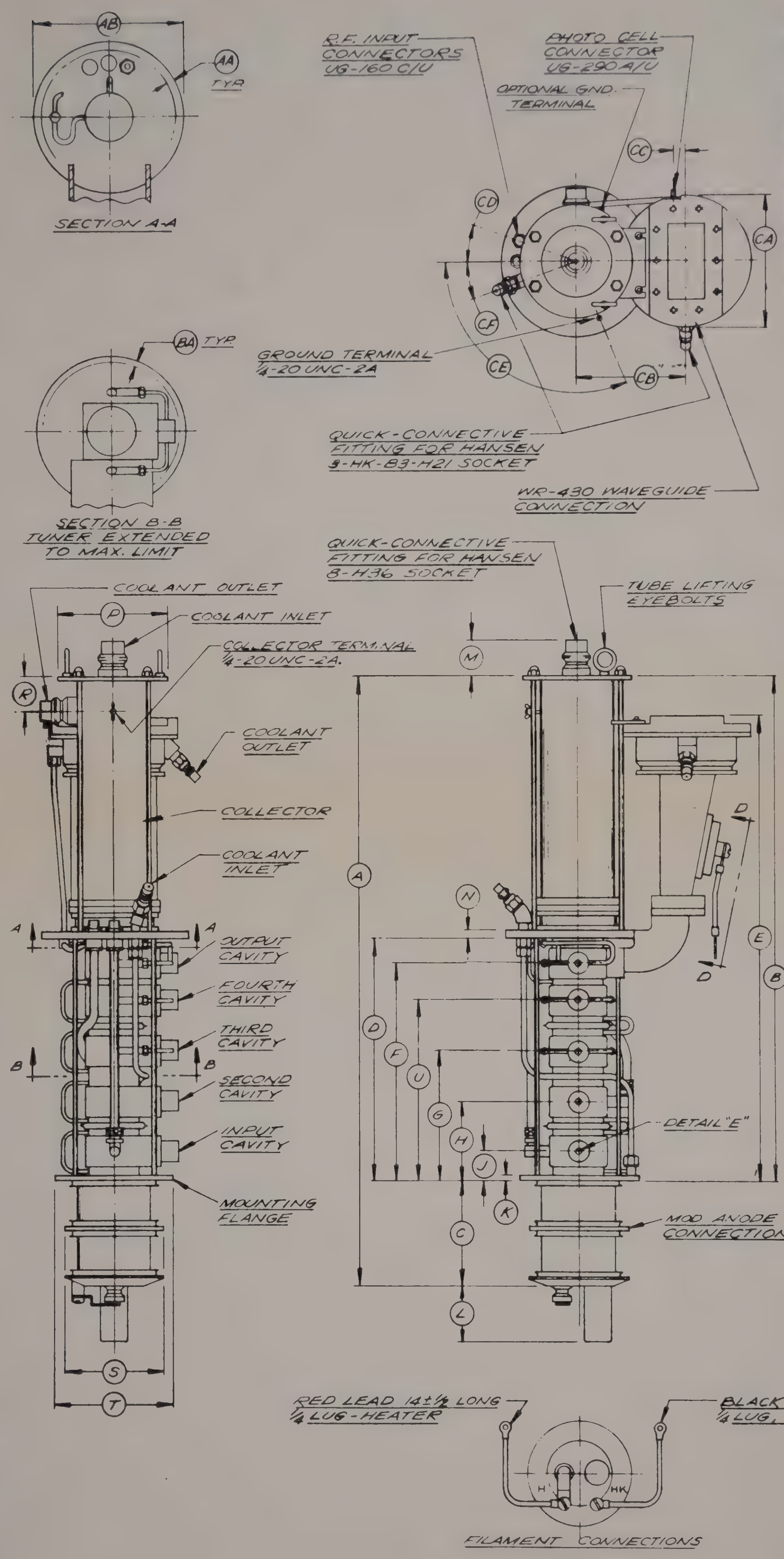
Frequency	2100	megacycles
Output Power	11.4	kilowatts
Driving Power	0.5	watts
Power Gain	43.5	decibels
Beam Voltage	18	kilovolts dc
Beam Current	1.75	amperes dc
Modulating-Anode Voltage (with respect to cathode)	10.3	kilovolts dc
Body Current	60	milliamperes dc
3 db Bandwidth	10	megacycles
Electromagnet Current	15	amperes

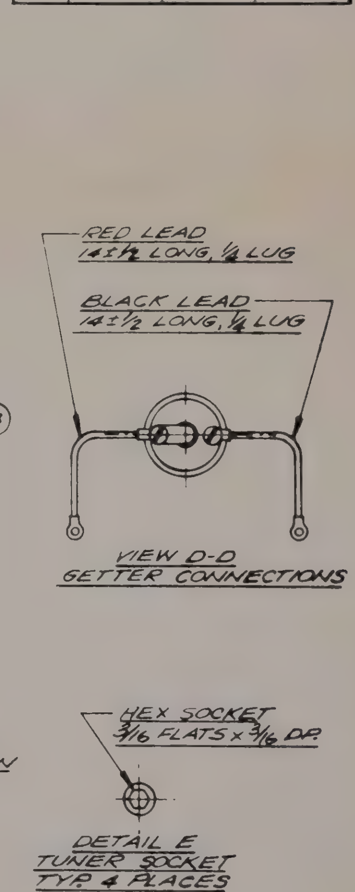
TYPICAL OPERATION — LINEAR AMPLIFIER (Two-Tone Conditions)

Frequencies	2098 and 2102	megacycles
Output Power (average)	3.8	kilowatts
Driving Power (each signal)	32.5	milliwatts
Driving Signal Separation	4	megacycles
Beam Voltage	17.8	kilovolts
Beam Current	1.8	amperes
Modulating Anode Voltage (with respect to cathode)	10.5	kilovolts
1 db Bandwidth	10	megacycles
3rd Order Intermodulation Products	—28	decibels
Output Power with Saturation Drive	11	kilowatts

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos Calfornia.

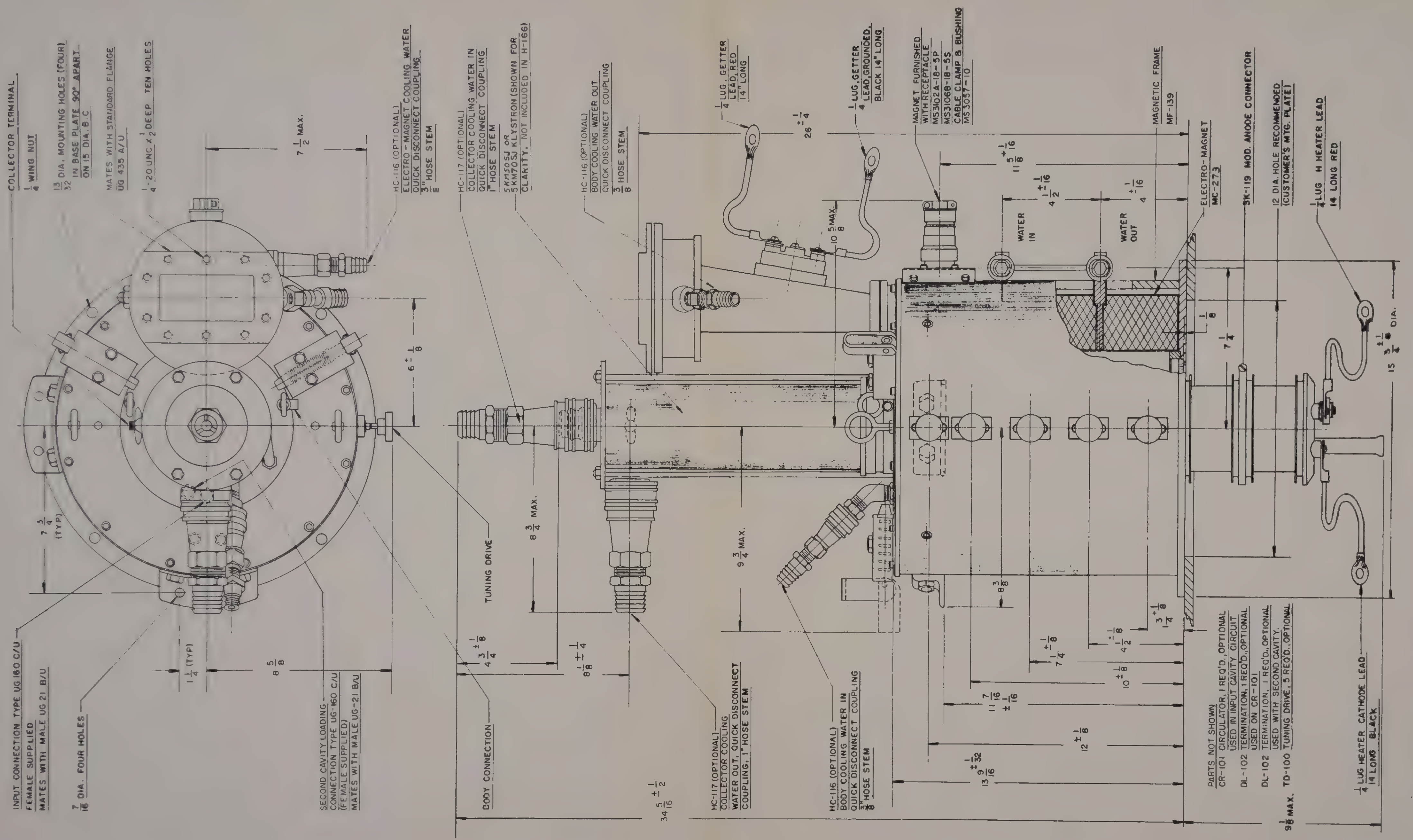
5KM50SJ Eimac





DIMENSIONAL DATA			
REF.	NOM	MIN.	MAX.
A	33.125		
B	27.420		
C	5.696		
D		13.080	13.270
E		26.410	26.700
F	11.875		
G	7.125		
H	4.375		
J	1.625		
K		.230	.270
L			3.250
M			2.000
N		.345	.405
P		5.950	6.050
R		1.470	1.720
S			5.280
T		6.490	6.500
U	9.875		
AA		.437	
AB		7.990	8.000
BA		.380	
CA		6.970	7.030
CB		5.750	6.250
CC		.510	.610
CD		15°	25°
CE		110°	120°
CF		15°	25°

5KM50SJ KLYSTRON



H-166 ELECTROMAGNET

EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

X3002

PULSE AMPLIFIER L-BAND KLYSTRON

The Eimac X3002 is a three-cavity, magnetically focused, pulse amplifier klystron. Designed for use at frequencies between 1235 and 1365 megacycles, this klystron will deliver a minimum peak output power of 4 kilowatts with a power gain of at least 23 decibels during long-pulse service.

Tuning for the X3002 is accomplished by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-147 is provided for use with the X3002 to cover the frequency range of 1235 to 1365 megacycles. This assembly includes a klystron supporting structure, focusing coils, external cavities, and adjustable load couplers for the input and output cavities.

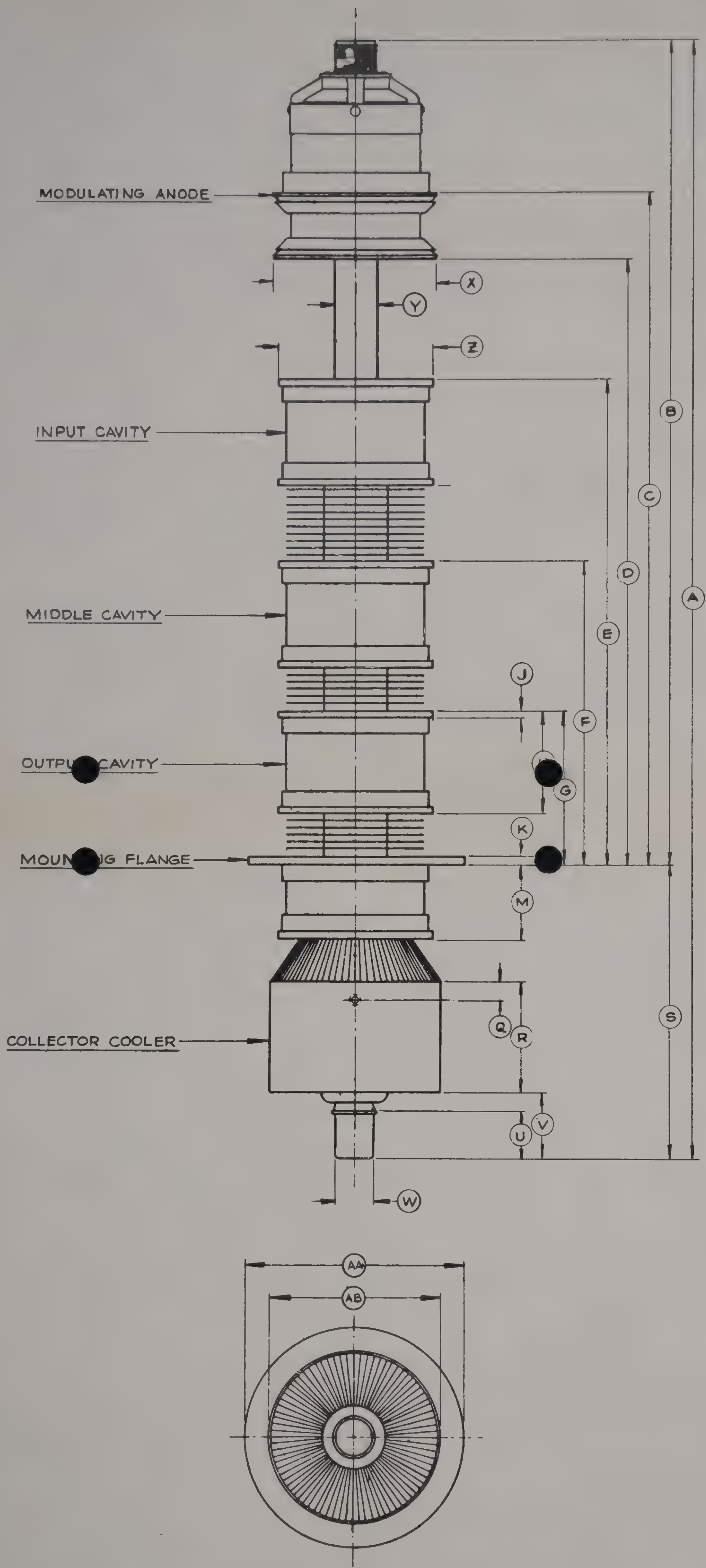
CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential		
Minimum Heating Time	5	minutes
Heater: Voltage (±5%)	7.5	volts
Current	5.5	amperes
Minimum Power Gain	23	decibels
Minimum Output Power	4	kilowatts
Frequency Range	1235 to 1365	megacycles
Phase Shift as a Function of Beam Voltage	0.0005	degrees/volt

MECHANICAL

Operating Position		Vertical, cathode end up
Coupling (rf): Input		Type "N", Coaxial Fitting
Output		⅞ inch, 50-ohm coaxial
Cooling: (20 degrees C inlet air at sea level)	*Flow Rate*	*Pressure Drop*
Body	100 cfm	1.5" H_2O
Collector	150 cfm	1.6" H_2O
X3002 Length		27 inches
X3002 Diameter		5.3 inches
X3002 Weight		23 pounds
H-147 Height		15 inches
H-147 Diameter		18 inches
H-147 Weight		155 pounds



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A	26.718		
B	19.750		
C	15.812		
D	14.312		
E	11.500		
F	7.250		
G	3.750		
H	2.500		
J	.250		
K	.250		
M	1.687		
Q	.437		
R	2.625		
S	6.968		
U	1.125		
V	1.812		
W	.875		
X	3.812		
Y	1.500		
Z	3.625		
AA	5.125		
AB	4.125		

X3002 OUTLINE DRAWING

X3002

FOCUS COIL POWER SUPPLY REQUIREMENTS

Body Coil	Variable to 200 volts, 3 amperes maximum
Prefocus Coil	Variable to 25 volts, 1.5 amperes maximum

TYPICAL OPERATION

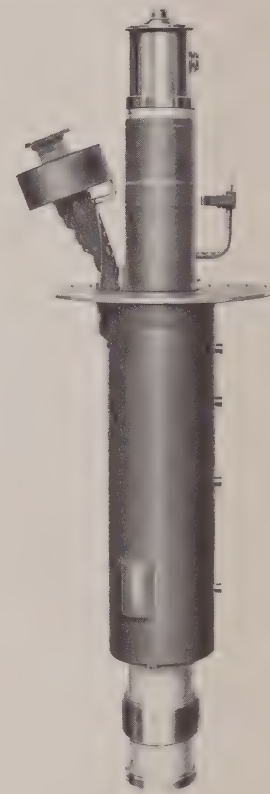
Pulse Amplifier

Frequency	1300	1300	megacycles
Peak Output Power	5	3.2	kilowatts
Power Gain	23	23	decibels
Beam Voltage	13	10	kilovolts dc
Peak Beam Current	1.12	0.91	amperes
Peak Modulating Anode Voltage	5.0	4.0	kilovolts
Focus Electrode Voltage	—50	—50	volts
Pulse Length	2000	2000	microseconds
Duty	3	3	percent
Efficiency	35	40	percent

For additional information or information regarding a specific application, write to Eimac Division, Varian Associates, 301 Industrial Way, San Carlos, California

X780

PULSE AMPLIFIER L-BAND KLYSTRON



The Eimac X780 is a pulse-amplifier klystron designed to operate at frequencies from 1235-1365 megacycles. This klystron will deliver a peak output power of 2.5 megawatts at 75 kilowatts average power, with a minimum saturated gain of 35 decibels. The small signal gain is in excess of 50 decibels.

Four integral cavities are used in the X780. The RF input and output coupling circuits are of the fixed broad-band type, optimized at maximum power. The output window is a thick beryllium oxide disc which will withstand severe abuse. The electron gun utilizes a confined flow configuration which results in a stable beam and non-critical focusing adjustments.

This klystron employs the Eimac Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. Also incorporated are two built-in vacuum pumps. One consists of an active titanium getter. The other is an ion pump which maintains a low vacuum pressure and provides for continuous monitoring of this pressure.

A focusing electromagnet and klystron supporting structure, Catalog Number H-145, has been designed for use with the X780.

CHARACTERISTICS

ELECTRICAL

Cathode: EMA, Unipotential		
Minimum Heating Time	10	minutes
Heater: Voltage (±5%)	7	volts
Current	90	amperes
Maximum Starting Current	180	amperes
Getter: Voltage (AC nominal)	4	volts
Current	20	amperes
Power Gain (minimum narrow band)	35	decibels
Peak Power Output	2.5	megawatts
Average Power Output	75	kilowatts
Frequency Range	1235-1365	megacycles
Phase: Beam Voltage Sensitivity	0.006	degree/volt
Ion Pump:		
Voltage DC	4000	volts
Current (0.1 megohm limiting resistor)	10	milliamperes
Beam Microperveance	1.5	
Electron Gun Microperveance	2.5	
Input VSWR (maximum)	1.5:1	

MECHANICAL

Operating Position	Vertical, Cathode End Down	
RF Input Coupling	EIA standard RS 225, ⅞" rigid coaxial fitting	
RF Output Coupling	RG69/U Flange	
Approximate Weight (tube only)	400	pounds
Approximate Weight (H-145 Magnetic Circuit)	1500	pounds

Cooling: Oil and Water

	Flow Rate	Pressure Drop
Cathode — Immersed in Oil		
Collector	60 gpm	40 psi
Klystron Body	5 gpm	25 psi
Electromagnet	2 gpm	30 psi

Fittings: Collector — Hansen B12 HK
Body — Hansen B4-K26
Electromagnet — Hansen B4-H26

Maximum Overall Dimensions (Klystron & Electromagnet):

Length	71	inches
Diameter	24	inches
Electromagnet Power Supply Requirements	2.5	kilowatts

MAXIMUM RATINGS

DC BEAM VOLTAGE	120	kilovolts
PEAK BEAM CURRENT	62.5	amperes
PEAK MODULATING ANODE VOLTAGE	88	kilovolts
AVERAGE DC BODY CURRENT	150	milliamperes
AC GETTER CURRENT	45	amperes
COLLECTOR DISSIPATION	250	kilowatts
SEAL TEMPERATURES	175	degrees C
LOAD VSWR	1.5:1	

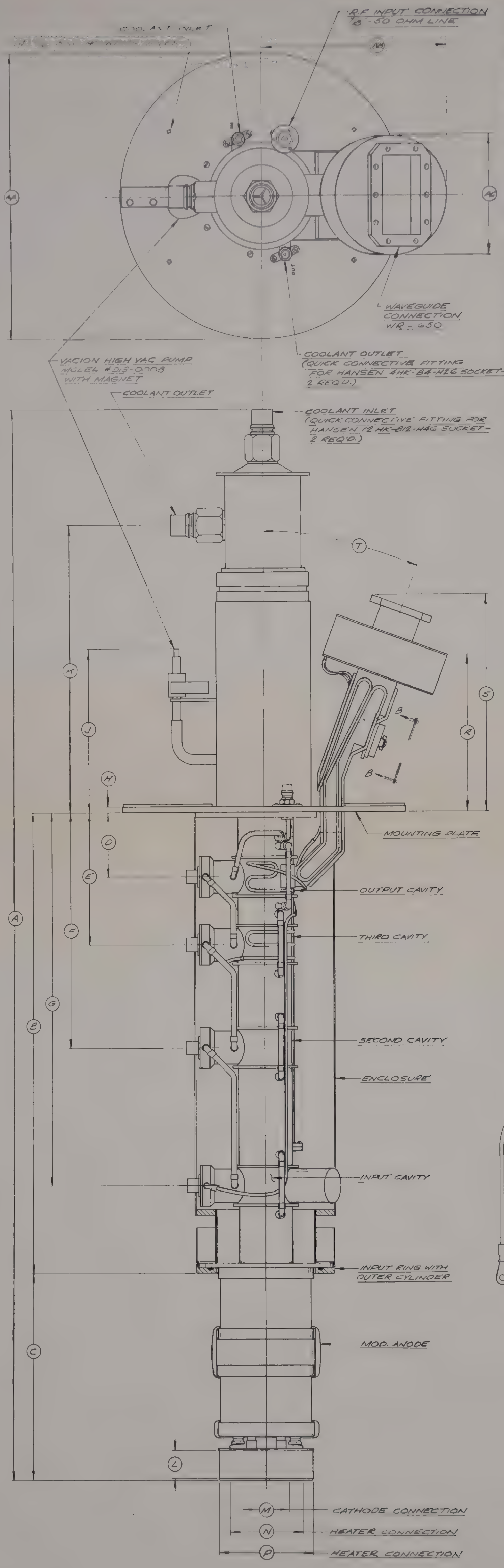
TYPICAL OPERATION, NARROW-BAND PULSE AMPLIFIER

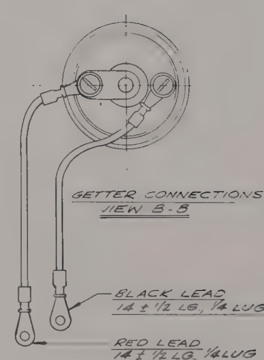
Frequency	1295	1295	megacycles
DC Beam Voltage	100	115	kilovolts
Peak Modulating-Anode Voltage	73.5	83.5	kilovolts
Peak Beam Current	41.8	58.6	amperes
Average DC Body Current	90	100	milliamperes
Peak Output Power	1.485	2.515	megawatts
Average Output Power	89	75.5	kilowatts
Peak Drive Power	0.475	0.790	kilowatts
Power Gain	35	35	decibels
Peak Beam Power Efficiency	35.6	36.8	percent
Pulse Width	2	1	millisecond
Pulse Repetition Rate	30	30	pulses/second
Duty	0.06	0.03	percent

For additional information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

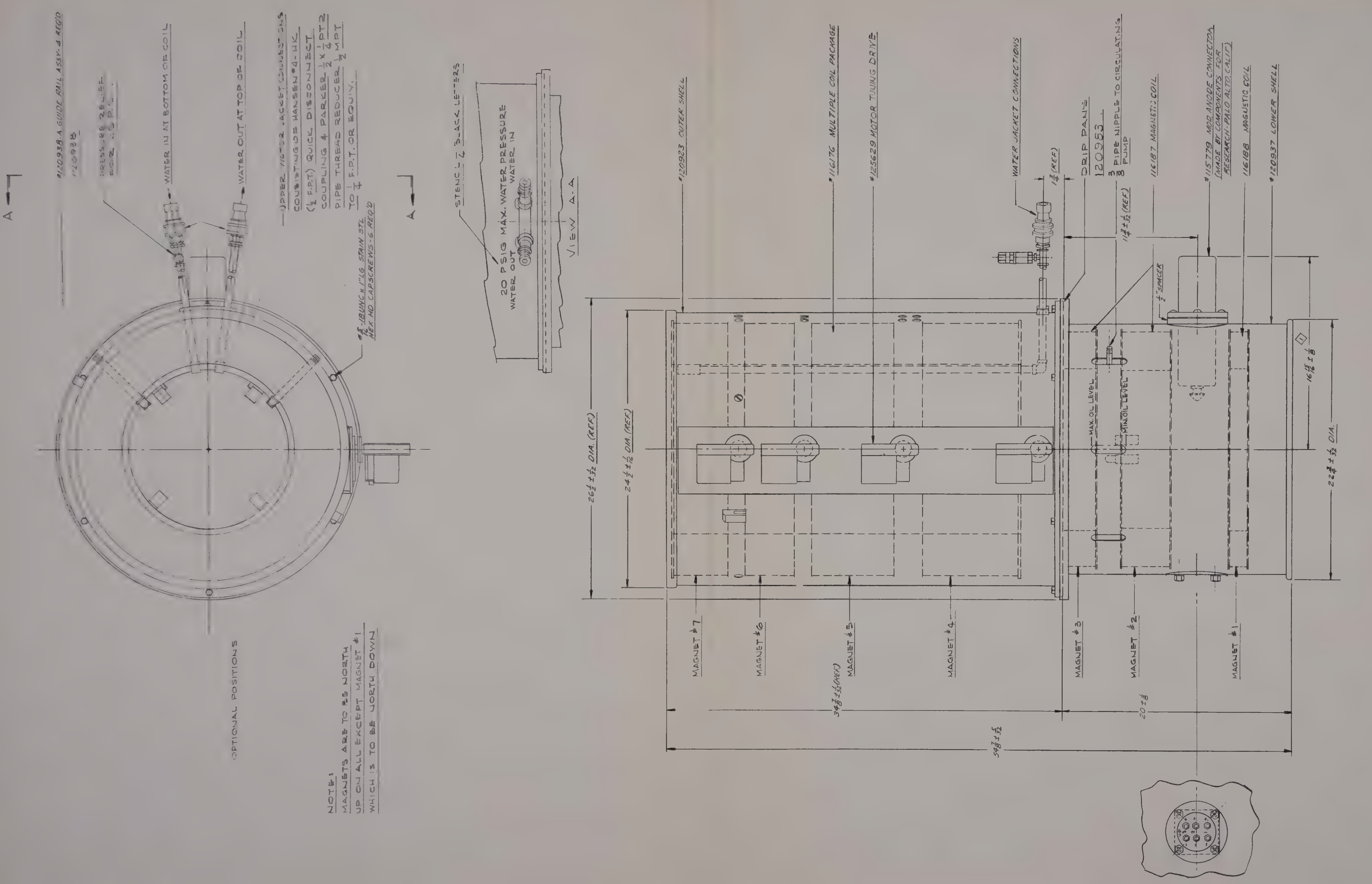
X780 Eimac

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A	92.[illegible]25		
B	40.250		
C	[illegible].25		
D	6.000		
E	11.812		
F	20.562		
G	32.312		
H	.500		
J	12.625		
K	24.750		
L	2.375		
M	4.000		
N	6.250		
P	8.000		
R	12.500		
S	.7750		
T	20°		
AA	24.000		
AB	5.000		
AC	10.000		





X780 KLYSTRON



H-145 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

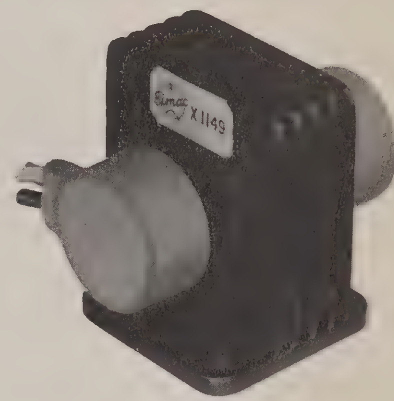
EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

X1149
Series

KU BAND
REFLEX KLYSTRON
1.0 W Min. Output



The Eimac X1149 series of ruggedized ceramic/metal reflex klystrons operates in the 12.4 to 18.0 Gc region with long life and high reliability. Tubes in the X1149 series deliver 1.0 W output at a voltage of only 800 V over a 100 Mc mechanical tuning range. External cavity tuning makes possible very stable operation. Wider tuning ranges can be supplied on special request.

The X1149 was designed for application as a multiple parametic amplifier pump source where excellent frequency and power stability are required. It also finds application in microwave links, doppler navigators, and other radar equipments.

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency	12.4 to 18.0 Gc
Mechanically Tunable	±50 Mc
Power Output	1.0 W (min.)
Electronic Tuning Range (3 db bandwidth)	70 Mc
Resonator Voltage	800 Vdc
Cathode Current	95 mA
Repeller Voltage	–50 to –400 Vdc
Repeller Modulation Sensitivity (3 db bandwidth)	0.6 to 0.9 Mc/V
Heater Voltage	6.3 ±5% Vac
Heater Current	1.3 A
VSWR of Load	1.2:1 (max.)
Temperature Coefficient	±250 Kc/°c
Warm-up Time	30 sec.

MAXIMUM RATINGS

Resonator Voltage	1000 Vdc
Cathode Current	110 mA
Repeller Voltage (negative with respect to cathode)	–50 Vdc

Note: Damage to the tube may occur if max. ratings are exceeded.

MECHANICAL

Electrical Connections (Type)	Flying Leads
Rf Output Coupling:	
(a) Flange size	UG419/U
(b) Waveguide size	RG91/U

Cooling Required — Conduction cooled thru waveguide flange*

Net Weight	7 oz.
Shipping Weight (approx.)	1 lb.

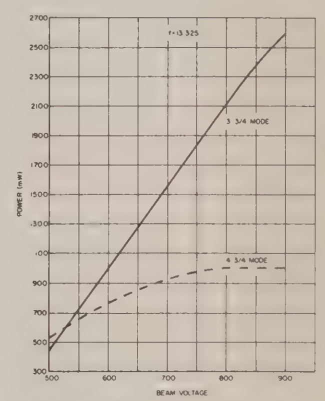
ENVIRONMENTAL PERFORMANCE

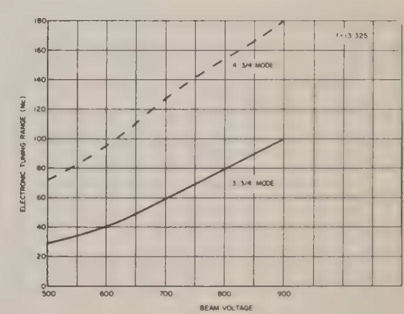
Temperature Range — Maintain body temperature below 150°C*

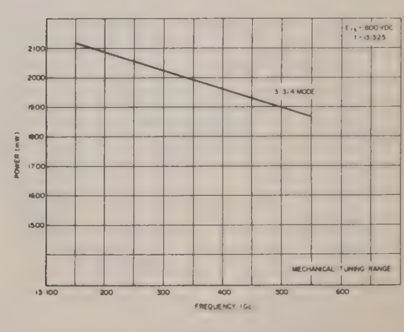
Altitude	100,000 ft.
Vibration	10 G, 20-2000 cps
Shock	40 G, 11 msec

*See Application Notes

KU BAND







Printed in U.S.A.

APPLICATION NOTES

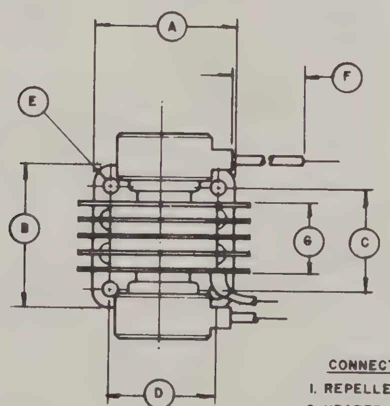
COOLING: The X1149 may be conduction cooled if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150°C. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be maintained below 100°C. Normal operating conditions will require convection cooling to maintain the desired body temperature.

RESONATOR: The resonator of the X1149 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 V if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1149 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage. When operating the heater from a DC supply, the positive side of the supply must be connected to the heater-cathode lead.

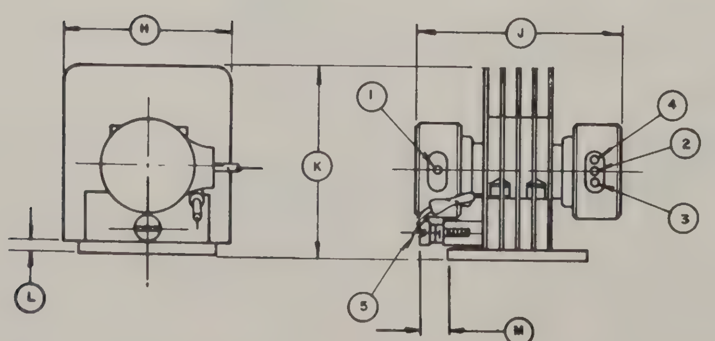
SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2000 cps) or shocks of up to 40g (11 milliseconds duration). With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143D.	.148D.	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		2.000	
L			.125
M		.562	

CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



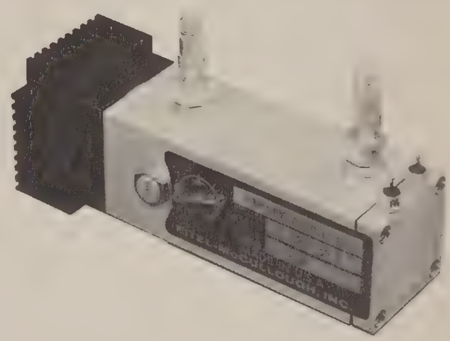
Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4523

CAVITY AMPLIFIER

2200-2300 Mc
20 Watts CW



The Model EM4523 cavity amplifier is a compact modular amplifier readily adaptable to airborne or ground support telemetry and communications systems. It is an optimum combination of the tube configuration with the associated rf circuit. Maximum efficiency and rf output from a very small package are outstanding features offered by this amplifier. Tuning can be accomplished with a minimum of test equipment.

CHARACTERISTICS

ELECTRICAL

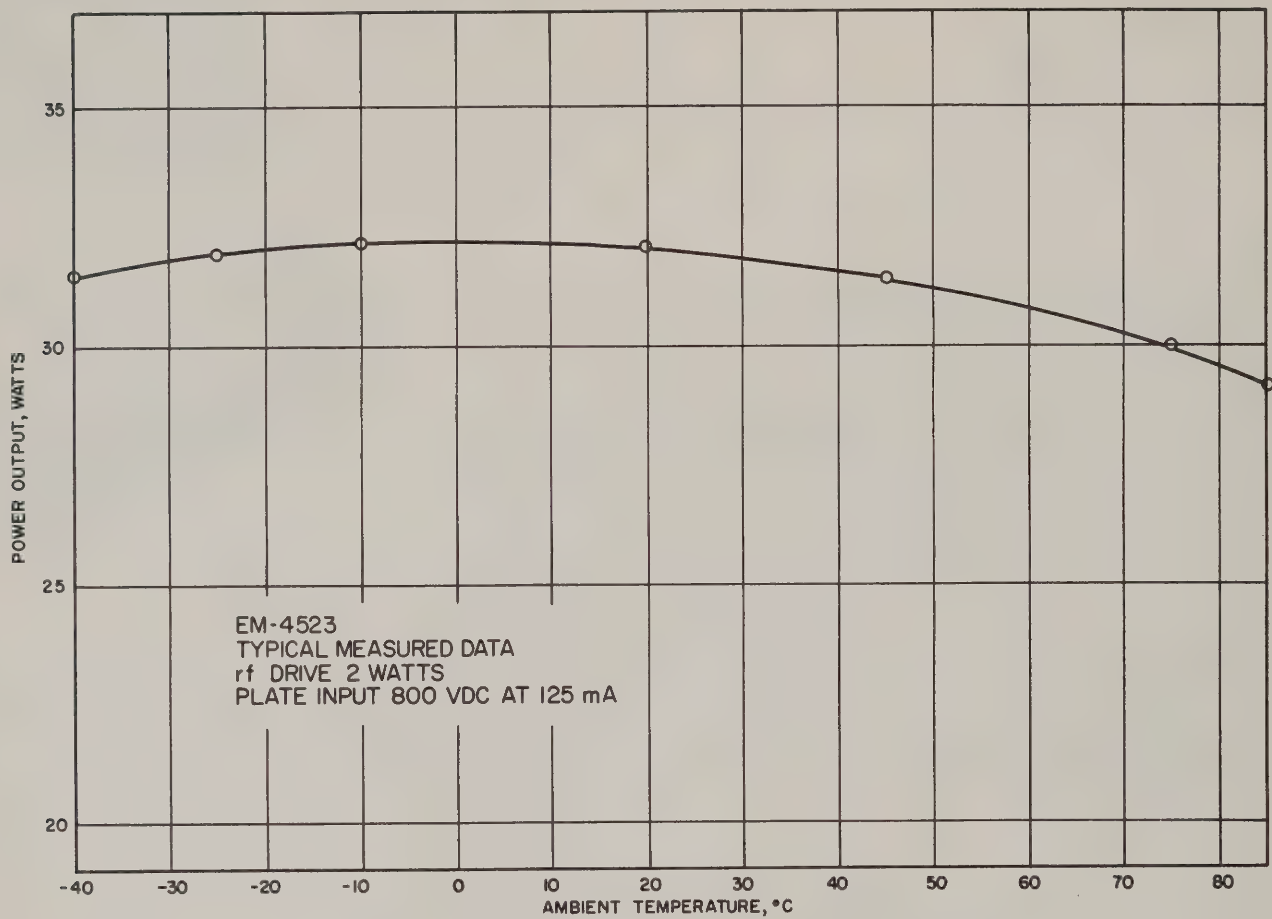
Tuning Range		2200-2300 Mc
Tube Type		Eimac A126066
Power Supply Requirements:		
Anode Voltage	800	V
Current	125	mA
Heater Voltage	6.0	V
Current	1.0	A
Operating Characteristics:		
Power Input	2.0	W
Power Output, Minimum	20	W
Modulation		CW/FM
Bandwidth, 3 db points	5	Mc
Frequency Stability	20	PPM/°C
Load Impedance	50	ohms nominal
Load VSWR	1.5:1	Any Constant Phase

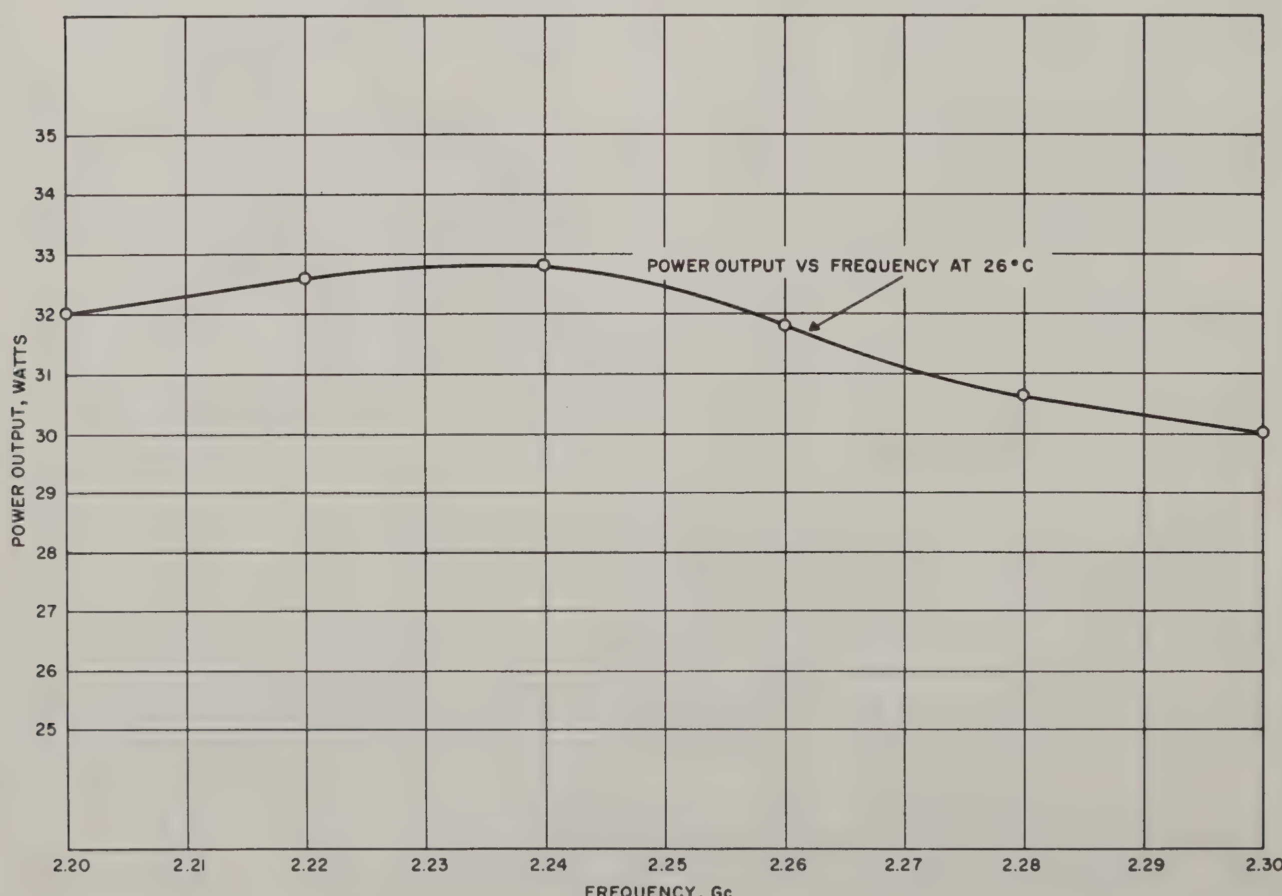
MECHANICAL

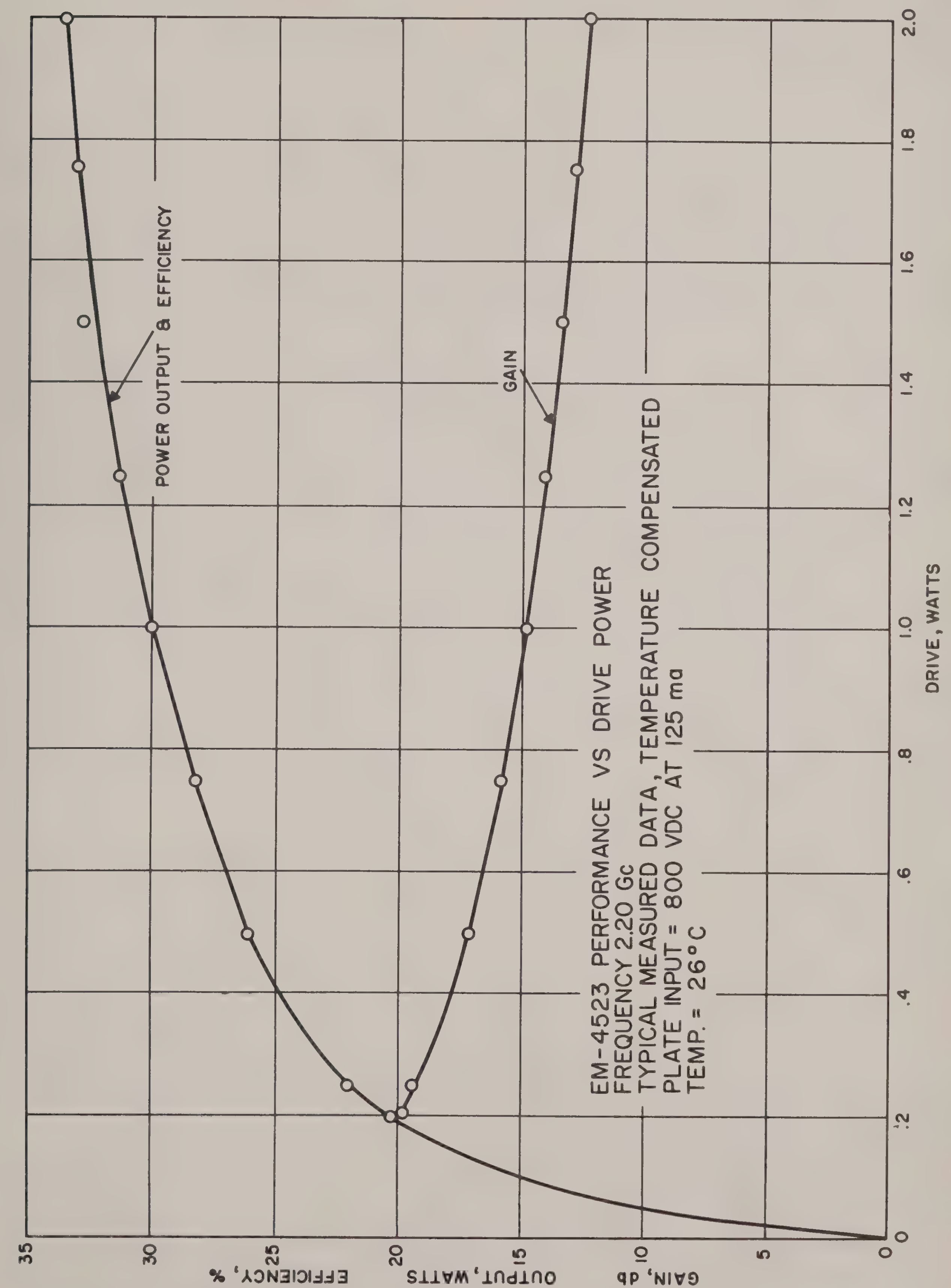
Connectors	Type OSM
Cooling	Conduction to heat sink
Maximum Overall Dimensions	1.25″ x 1.25″ x 4⅜″
Net Weight	1.2 pounds

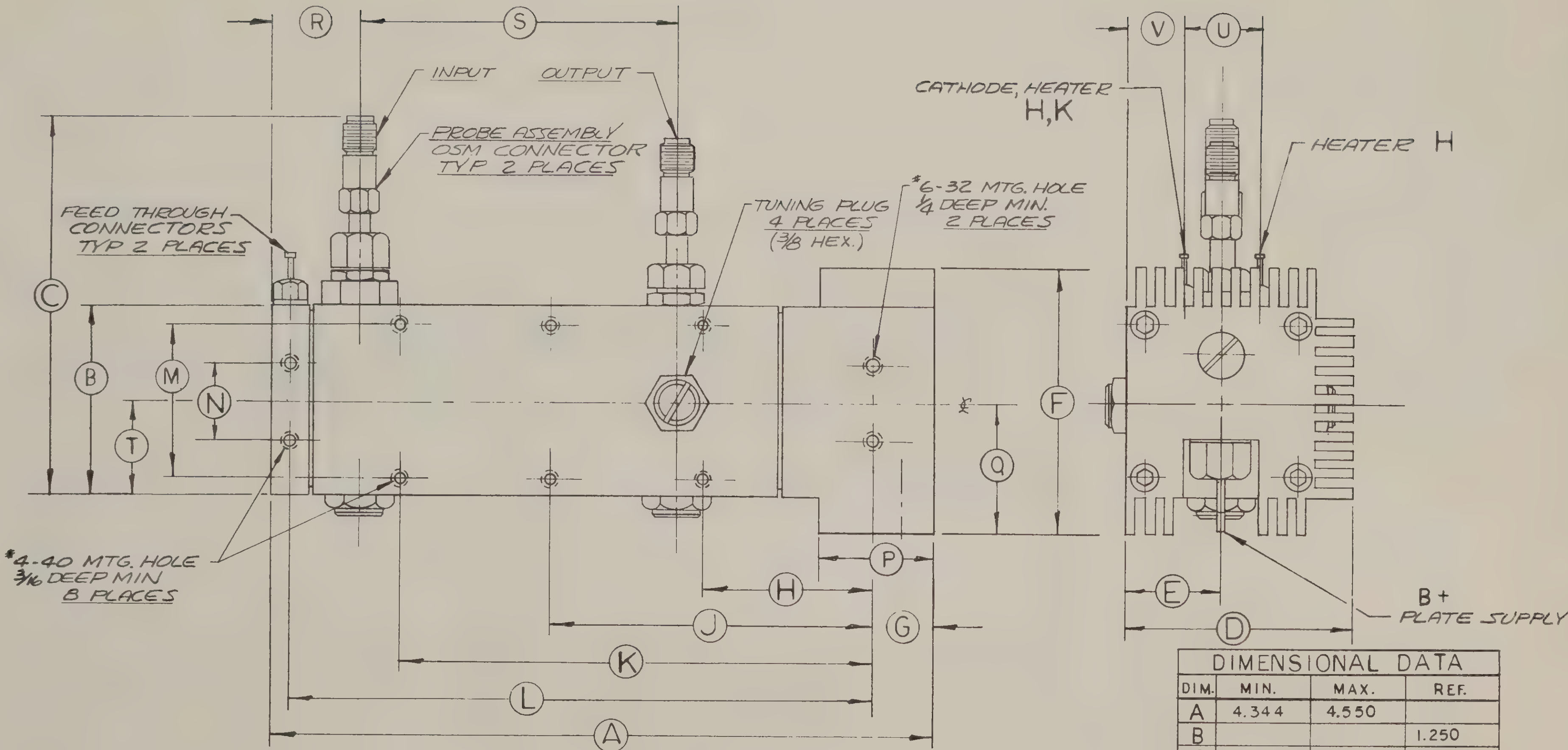
ENVIRONMENTAL

Mounting Surface Temperature	–40° to +85°C
Vibration	10g, 5-500 cycles, 15 minutes in 3 mutually perpendicular planes
Shock	15g for 11 milliseconds in 3 mutually perpendicular planes


35
30
25
20
POWER OUTPUT, WATTS
EM-4523
TYPICAL MEASURED DATA
rf DRIVE 2 WATTS
PLATE INPUT 800 VDC AT 125 mA
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80
AMBIENT TEMPERATURE, °C


35
34
33
32
31
30
29
28
27
26
25
POWER OUTPUT, WATTS
POWER OUTPUT VS FREQUENCY AT 26°C
2.20 2.21 2.22 2.23 2.24 2.25 2.26 2.27 2.28 2.29 2.30
FREQUENCY, Gc


EM-4523 PERFORMANCE VS DRIVE POWER
FREQUENCY 2.20 Gc
TYPICAL MEASURED DATA, TEMPERATURE COMPENSATED
PLATE INPUT = 800 VDC AT 125 ma
TEMP. = 26°C
POWER OUTPUT & EFFICIENCY
GAIN
DRIVE, WATTS
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
EFFICIENCY, %
OUTPUT, WATTS
GAIN, db
0
5
10
15
20
25
30
35



DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	4.344	4.550	
B			1.250
C			2.500
D			1 1/2 IN.
E			.625
F	1.735	1.765	
G			.302
H	1.130	1.170	
J	2.130	2.170	
K	3.130	3.170	
L	3.860	3.890	
M	1.045	1.055	
N	.495	.505	
P			.750
Q			.875
R	.560	.590	
S			2.106
T			.625
U	.458	.478	
V	.375	.406	

EIMAC

A Division of Varian Associates

EM4524A

CAVITY AMPLIFIER

2200-2300 Mc

100 WATTS CW

Tentative Data

The Model EM4524A cavity amplifier is a compact modular amplifier readily adaptable to airborne or ground support telemetry and communications systems. The Model EM4524A is an optimum combination of the tube configuration with the associated RF circuit. Maximum efficiency and rf output from a very small package are outstanding features offered by this amplifier. Tuning can be accomplished with a minimum of test equipment.

CHARACTERISTICS

ELECTRICAL

Tuning Range		2200-2300 Mc
Tube Type		Eimac X843G
Power Supply Requirements:		
Anode Voltage	1000	V
Current	350	mA
Heater Voltage	6.0	V
Current	2.7	A
Operating Characteristics:		
Power Input	10	W
Power Output	100	W
Modulation		CW/FM
Bandwidth, 3db points	7	Mc
Frequency Stability	20	PPM/°C
Load Impedance	50	ohms nominal
Load VSWR	1.5:1	Any Constant Phase
Gain	10	DB

MECHANICAL

Connectors	OSM Input, Type N Output
Cooling	Conduction
Maximum Overall Dimensions	2″ x 2″ x 6″
Net Weight	3 pounds

ENVIRONMENTAL

Mounting Surface Temperature	–40 to +100°C
Vibration	Shall meet the requirements of Method 514, MIL-Standard-810, Class 1 through 4 and mounting Type A.
Shock	Shall meet the requirements of Procedure 1, Method 516 of MIL-Standard-810.

EIMAC
A Division of Varian Associates

TABLE OF CONTENTS
VOL. I

*Not recommended for New Equipment Design.

Effective Date 9-30-65

Eimac®

EITEL-McCULLOUGH, INC.

8163
3400Z
HIGH-MU POWER TRIODE

The Eimac 8163/3-400Z is a compact power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias simplifies associated circuity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 8163/3-400Z in a cathode-driven circuit.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament:	Thoriated Tungsten		
	Voltage	5.0	volts
	Current	14.5	amperes
	Amplification Factor (Average)	200	
Interelectrode Capacitances (Average): †			
	Grid-Filament	7.4	uuf
	Grid-Plate	4.1	uuf
	Plate-Filament	0.07	uuf
Frequency for Maximum Ratings		110	Mc

MECHANICAL

Base		5 Pin Special
Basing		See Drawing
Mounting Position		Vertical, base down or up
Cooling		Radiation and forced air
Heat-Dissipating Plate Connector		Supplied mounted on tube
Recommended Socket		Eimac SK-410
Recommended Chimney		Eimac SK-416
Maximum Operating Temperatures:		
	Plate Seal	225°C
	Base Seals	200°C
Maximum Over-all Dimensions:		
	Height	5.25 inches
	Diameter	3.57 inches
Net Weight		7 ounces

† In Shielded Fixture

R-F LINEAR AMPLIFIER
GROUNDED-GRID, CLASS-B

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	0.400 MAX. AMP
PLATE DISSIPATION	400 MAX. WATTS
GRID DISSIPATION	20 MAX. WATTS

TYPICAL OPERATION (Single-Tone Conditions)

D-C Plate Voltage	3000 volts
Zero-Sig D-C Plate Current*	100 ma
Max-Sig D-C Plate Current	333 ma
Max-Sig D-C Grid Current	120 ma
Driving Impedance	122 ohms
Resonant Load Impedance	4750 ohms
Max-Sig Driving Power	32 watts
Peak Envelope Plate Output Power	655 watts

TYPICAL OPERATION (Minimum Distortion Products at 1 KW PEP Input)

D-C Plate Voltage	2500 volts
Zero-Sig D-C Plate Current*	73 ma
Single-Tone D-C Plate Current	400 ma
Single-Tone D-C Grid Current	142 ma
Two-Tone D-C Plate Current	274 ma
Two-Tone D-C Grid Current	82 ma
Peak Envelope Useful Output Power	560 watts
Resonant Load Impedance	3450 ohms

Intermodulation Distortion
Products - 35 db or more below PEP level

TYPICAL OPERATION (Minimum Distortion Products)

D-C Plate Voltage	2000 volts
Zero-Sig D-C Plate Current*	62 ma
Single-Tone D-C Plate Current	400 ma
Single-Tone D-C Grid Current	148 ma
Two-Tone D-C Plate Current	265 ma
Two-Tone D-C Grid Current	87 ma
Peak Envelope Useful Output Power	445 watts
Resonant Load Impedance	2750 ohms

Intermodulation Distortion
Products - 40 db or more below PEP level

TYPICAL OPERATION (Minimum Distortion Products at 1500 Volts Plate Voltage)

D-C Plate Voltage	1500 volts
Zero-Sig D-C Plate Current*	46 ma
Single-Tone D-C Plate Current	400 ma
Single-Tone D-C Grid Current	163 ma
Two-Tone D-C Plate Current	265 ma
Two-Tone D-C Grid Current	92 ma
Peak Envelope Useful Output Power	300 watts
Resonant Load Impedance	1620 ohms

Intermodulation Distortion
Products - 37 db or more below PEP level

AUDIO FREQUENCY AMPLIFIER
OR MODULATOR, CLASS-B

MAXIMUM RATINGS (PER TUBE)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	0.400 MAX. AMP
PLATE DISSIPATION	400 MAX. WATTS
GRID DISSIPATION	20 MAX. WATTS

TYPICAL OPERATION (Sinusoidal Wave, Two Tubes, Grid Driven)

D-C Plate Voltage	3000 volts
D-C Grid Voltage	0 volts
Zero-Sig D-C Plate Current*	200 ma
Max-Sig D-C Plate Current	666 ma
Max-Sig D-C Grid Current	240 ma
Driving Power	26 watts
Peak A-F Driving Voltage (per tube)	88 volts
Load Resistance, Plate-to-Plate	9500 ohms
Max-Sig Plate Output Power	1310 watts

*Approximate Value

R-F POWER AMPLIFIER
OR OSCILLATOR, CLASS-C

MAXIMUM RATINGS		
D-C PLATE VOLTAGE	4000 MAX.	VOLTS
D-C PLATE CURRENT	0.350 MAX.	AMP
PLATE DISSIPATION	400 MAX.	WATTS
GRID DISSIPATION	20 MAX.	WATTS

TYPICAL OPERATION	
D-C Plate Voltage	3000 volts
D-C Plate Current	333 ma
D-C Grid Voltage	-75 volts
D-C Grid Current	130 ma
Peak R-F Grid Voltage	187 volts
Grid Driving Power	25 watts
Plate Output Power	730 watts

PLATE-MODULATED
R-F POWER AMPLIFIER

MAXIMUM RATINGS		
D-C PLATE VOLTAGE	3000 MAX.	VOLTS
D-C PLATE CURRENT	0.275 MAX.	AMP
PLATE DISSIPATION	270 MAX.	WATTS
GRID DISSIPATION	20 MAX.	WATTS

TYPICAL OPERATION	
D-C Plate Voltage	3000 volts
D-C Plate Current	245 ma
D-C Grid Voltage	-90 volts
D-C Grid Current	100 ma
Peak R-F Grid Voltage	185 volts
Grid Driving Power	18 watts
Plate Output Power	550 watts

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinguished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment(s) and the output power is that measured at the load.

APPLICATION

Mounting -- The 3-400Z must be operated vertically, base up or base down. A flexible connecting strap should be provided between the heat dissipating plate connector and the external plate circuit. The tube must be protected from severe vibration and shock.

Cooling --Forced-air cooling is required to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C. When using the Eimac SK-410 Air-System Socket and SK-416 Chimney, a minimum air flow rate of 13 cubic feet per minute at a static pressure of approximately 0.13 inch of water at sea level is required to provide adequate cooling at an inlet air temperature of 55°C. At higher inlet air temperatures, higher altitudes, or at frequencies above 30 Mc, the air flow rate must be increased to give equivalent cooling. Cooling air must be supplied to the tube even when the filament alone is on during standby periods.

When a socket other than the SK-410 is used, provisions must be made for equivalent cooling of the base, the envelope, and the plate lead. In all cases, air flow rates in excess of the minimum requirements will prolong tube life.

Class-C Operation -- Although specifically designed for class-B service, the 3-400Z may be operated as a class-C power amplifier or oscillator or as a plate-modulated radio-frequency power amplifier. The zero-bias characteristic of the 3-400Z can be used to advantage in class-C amplifiers operating at plate voltages of 3000 volts or below be employing only grid-leak bias. If driving power fails, plate dissipation is then kept to a low value because the tube will be operating at the normal static zero-bias conditions.

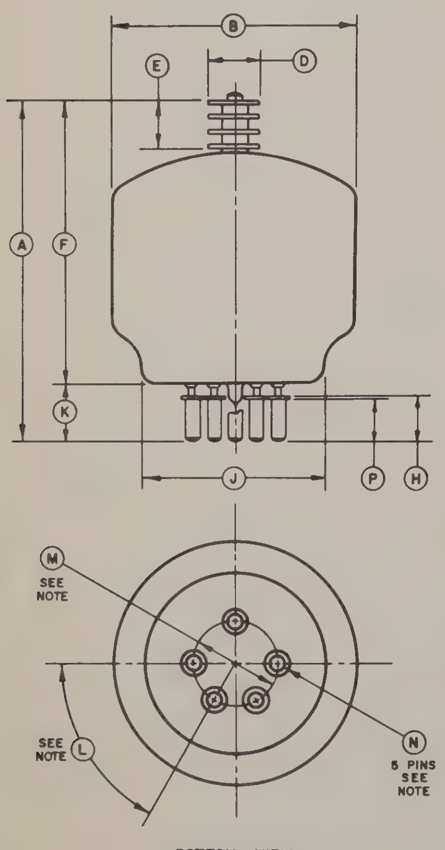
Filament Operation -- The rated filament voltage for the 3-400Z is 5.0 volts. Filament voltage, as measured at the socket, must be maintained within the range of 4.75 to 5.25 volts to obtain maximum tube life.

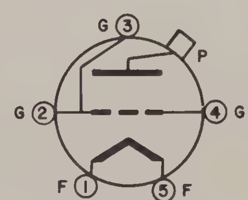
Intermodulation Distortion -- Typical Operating conditions with distortion values included are the result of data taken during actual operation at 2 megacycles. Intermodulation values listed are those measured at the full peak envelope power noted. As the driving signal level is reduced, distortion products remain at the listed value, or better, below original peak envelope power level.

Input Circuit -- When the 3-400Z is operated as a grounded-grid r-f amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

Special Applications -- If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

3-400Z OUTLINE DRAWING AND PIN CONNECTIONS

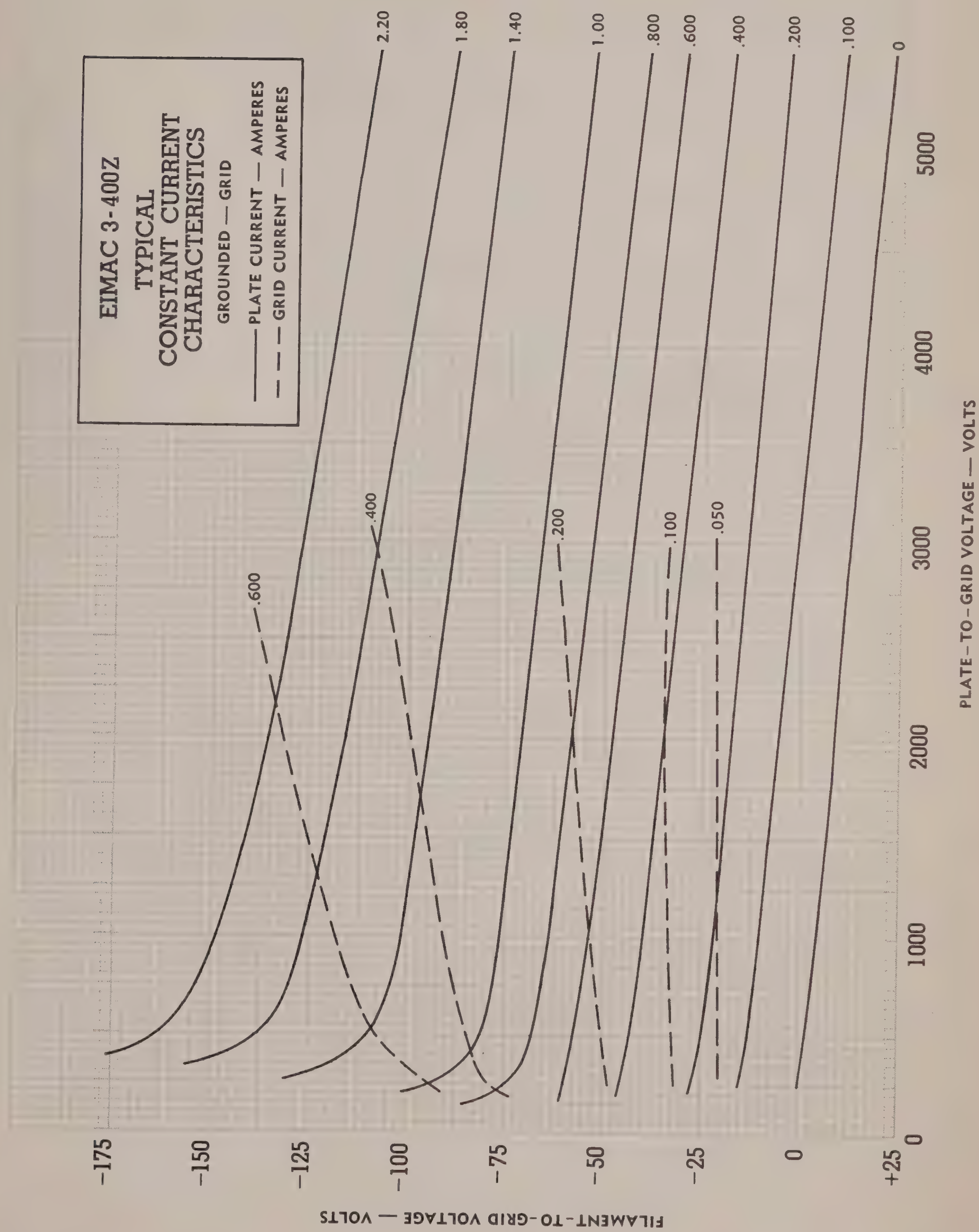




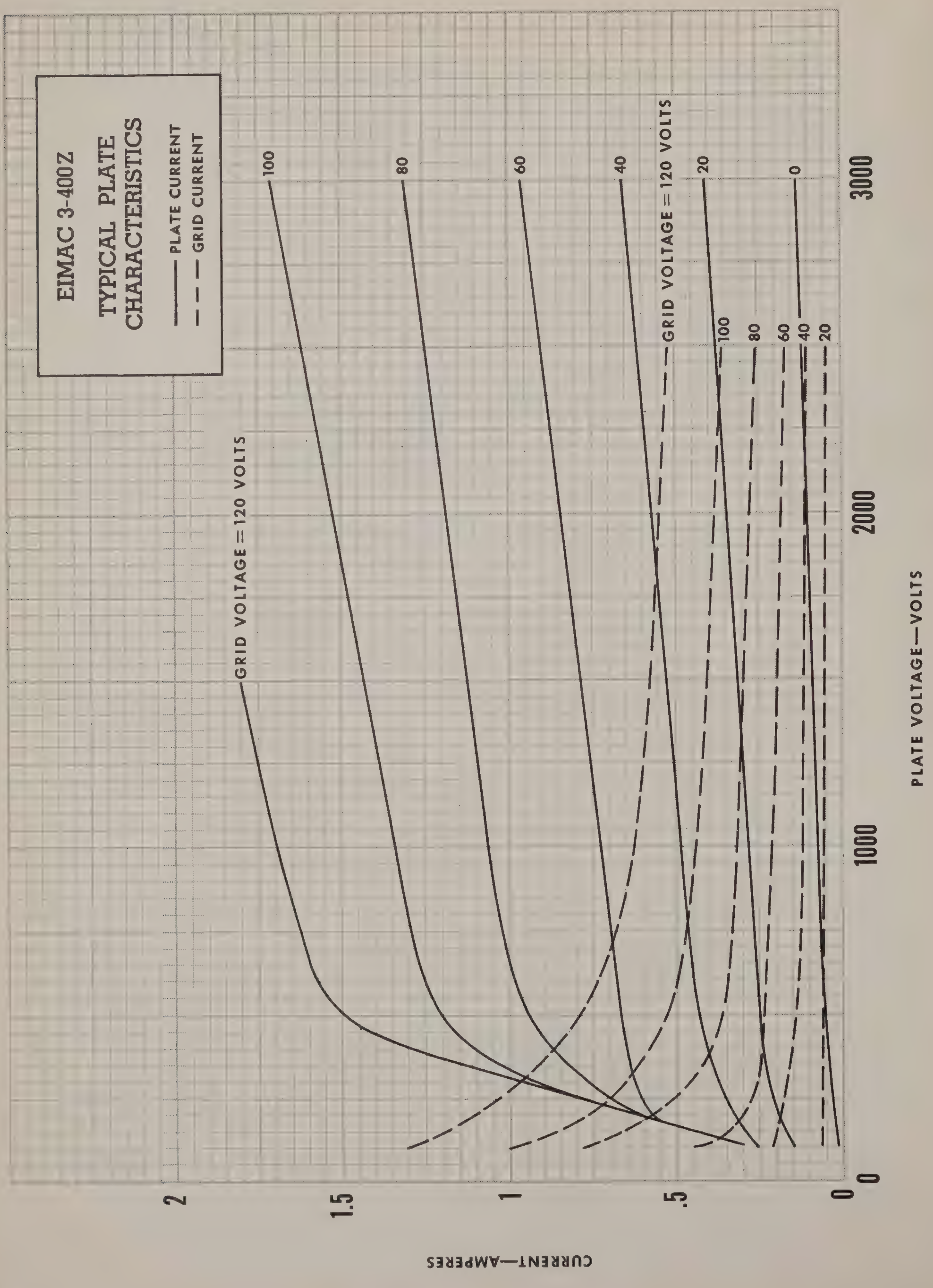
NOTE:
BASE PINS (N) ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAUGE 1/4" THICK WITH HOLE DIA'S. OF .204 LOCATED ON THE TRUE CENTERS BY THE GIVEN DIMS. (L) & (M).

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4-3/4	5-1/4	
B		3-9/16 D.	
D	.745 D.	.755 D.	
E	.640	.660	
F	3-15/16	4-7/16	
H	9/16	11/16	
J		2-1/2 D.	
K			13/16
L			60° TYP.
M			1-1/4 D. P.C.
N	.185 D.	.191 D.	
P	1/2	5/8	


EIMAC 3-400Z
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED — GRID
——— PLATE CURRENT — AMPERES
— — — GRID CURRENT — AMPERES
2.20
1.80
1.40
1.00
.800
.600
.400
.200
.100
0
.600
.400
.200
.100
.050
FILAMENT-TO-GRID VOLTAGE — VOLTS
−175
−150
−125
−100
−75
−50
−25
0
+25
PLATE-TO-GRID VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000

3 5


EIMAC 3-400Z
TYPICAL PLATE CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
GRID VOLTAGE = 120 VOLTS
100
80
60
40
20
0
GRID VOLTAGE = 120 VOLTS
100
80
60
40
20
0
1000
2000
3000
PLATE VOLTAGE—VOLTS
0
.5
1
1.5
2
CURRENT—AMPERES

The X6007 nuclear battery made by Eimac, is a source of energy characterized by very long life, high reliability and low power. It should be considered as a constant current generator. The magnitude of this current can be selected by the amount of radioactive material used, but will usually be less than 10^{-7} amps. This current can be used directly into the load or it can be stored as in a condenser for periodic use at a high power level. Since the source of energy is a nuclear decay, the life is ultimately controlled by the half life of the material and is measured in years. Likewise, the reliability is that of nuclear decay.

The X6007 nuclear battery utilizes 5% Krypton 85 gas as an electron beta source sealed within a glass ampoule. The glass ampoule acts as a dielectric through which high energy electrons pass and are collected by a graphite collector. The outer surface of the battery is nickel plated to provide the negative conductor attachment. The positive conductor is provided by the copper tubulation projecting from the top of the glass ampoule.

The X6007 nuclear battery can provide voltages in excess of 10,000 volts, and will charge linearly to 1000 volts at 7.5 volts/sec, no load charging rate. The voltage-current relationship at room temperature for a minimum of six months are as follows:

Zero Volt Output: With less than 1 x 10^{10} ohms load, current output will exceed 1050 picoamperes.

1000 Volt Output: At 1000 volts DC, current output will exceed 1000 picoamperes.

2000 Volt Output: At 2000 volts DC, current output will exceed 950 picoamperes.

3000 Volt Output: At 3000 volts DC, current output will exceed 900 picoamperes.

The minimum useful life of the X6007 nuclear battery is 10 years, approximately 50% of new battery current capability.

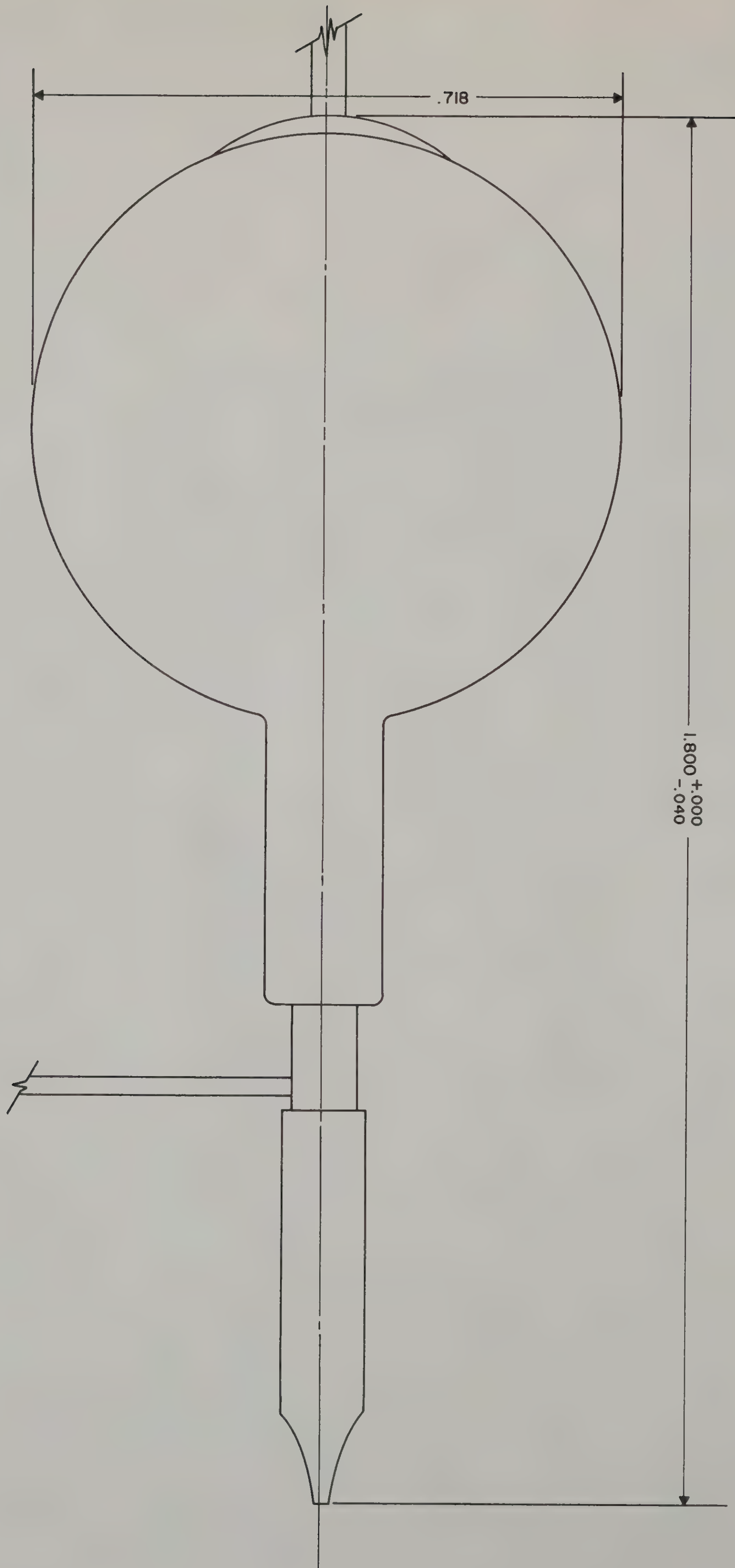
The X6007 nuclear battery ampoule can be made available in a number of packaging configurations. Terminals can be provided as solder lugs, binding posts or military specification miniature cable connectors, etc.

General configuration of a stainless steel cylinder 1 inch dia x 1½ inches long having the ampoule packaged for high resistance to mechanical shock, vibration, pressure or extreme temperatures, provides a high reliability, long life device.

SPECIFICATIONS

Dimensions:	.718 dia (23/32) x $1.80^{+.00}_{-.04}$ overall height incl. tubulation
Weight:	7 gms
Storage Temperature:	–110°F to +225°F
Operating Temperature:	–65°F to +165°F (1000 picoamperes @ 1000 V)
Mechanical Shock:	215g, 7 milliseconds
Thermal Shock:	Cycling from –65°F to +165°F
Bulb Pressure Test:	350 psig
Helium Leak Test:	Random vibration with flat power spectrum from 20 to 2000 cps at $0.312g^2$/cps level for 20 minutes

 Printed in U.S.A.



.718
1.800 +.000 -.040

Eimac®

EITEL-McCULLOUGH, INC.

4KM70LA

POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM70LA is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 470 to 610 megacycles. Intended primarily for television visual service, it is also suitable for aural TV, or for tropospheric-scatter communications service.

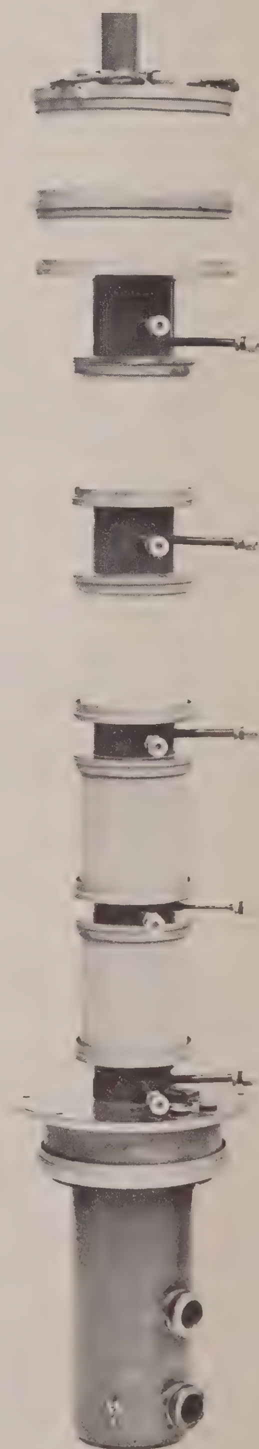
In television visual service the 4KM70LA will provide more than 12.5 kilowatts of peak synchronizing power, with a power gain of 30 decibels, and 1 db bandwidth of 8 megacycles. Random AM noise is more than 60 db below black level.

The electron gun of this klystron utilizes a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. The cathode loading of only 75 milliamperes per square centimeter, at a beam voltage of 14 kilovolts, is ultra-conservative in the interest of long life. Effective protection from internal arcs is provided by the Eimac Modulating Anode.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. Load couplers are provided to permit external loading of these cavities for extreme wideband operation.

The 4KM70LA incorporates a built-in vacuum pump in the form of a titanium getter. This getter should be energized whenever heater power is applied. Its normal operating voltage is 3.7 volts at approximately 20 amperes.

Eimac Klystron Amplifier Circuit Assembly H-163 has been designed for use with the 4KM70LA to cover the specified frequency range. This assembly includes a klystron supporting structure, focusing electromagnet, tuning cavities, and adjustable load couplers for each cavity.



CHARACTERISTICS

ELECTRICAL

Heater:	DC Voltage	26.0	volts
	DC Current	11.5	amperes
	Maximum Starting Current	23	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	AC Voltage (±5%)	3.7	volts
	AC Current	20	amperes

ELECTRICAL (continued)

Power Gain:	Television Visual Service	30	decibels
Output Power:	Television Visual Service	12.5	kilowatts
Frequency Range:	(H-163 Assembly)	470 to 610	megacycles

MECHANICAL

Operating Position		Axis vertical, cathode up
RF Coupling:		
Input		Type "N" coaxial fitting
Output		3-1/8 inch, 50-ohm line
Input and 2nd Cavity Loading		Type "N" coaxial fitting
3rd Cavity Loading		1-5/8 inch. 50-ohm line
Approximate Weights:		
Klystron only	110	pounds
H-163 RF Circuit Assembly	1800	pounds
Cooling: Water and Forced Air		

	Flow Rate	Pressure Drop
Cathode	*5 cfm	-------
Cavity	50 cfm	TBS
Klystron Body and Electromagnet in Series	2 gpm	45 psi
Klystron Collector	30 gpm	7.5 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	0 to 150	volts
Current	0 to 12	amperes

MAXIMUM RATINGS

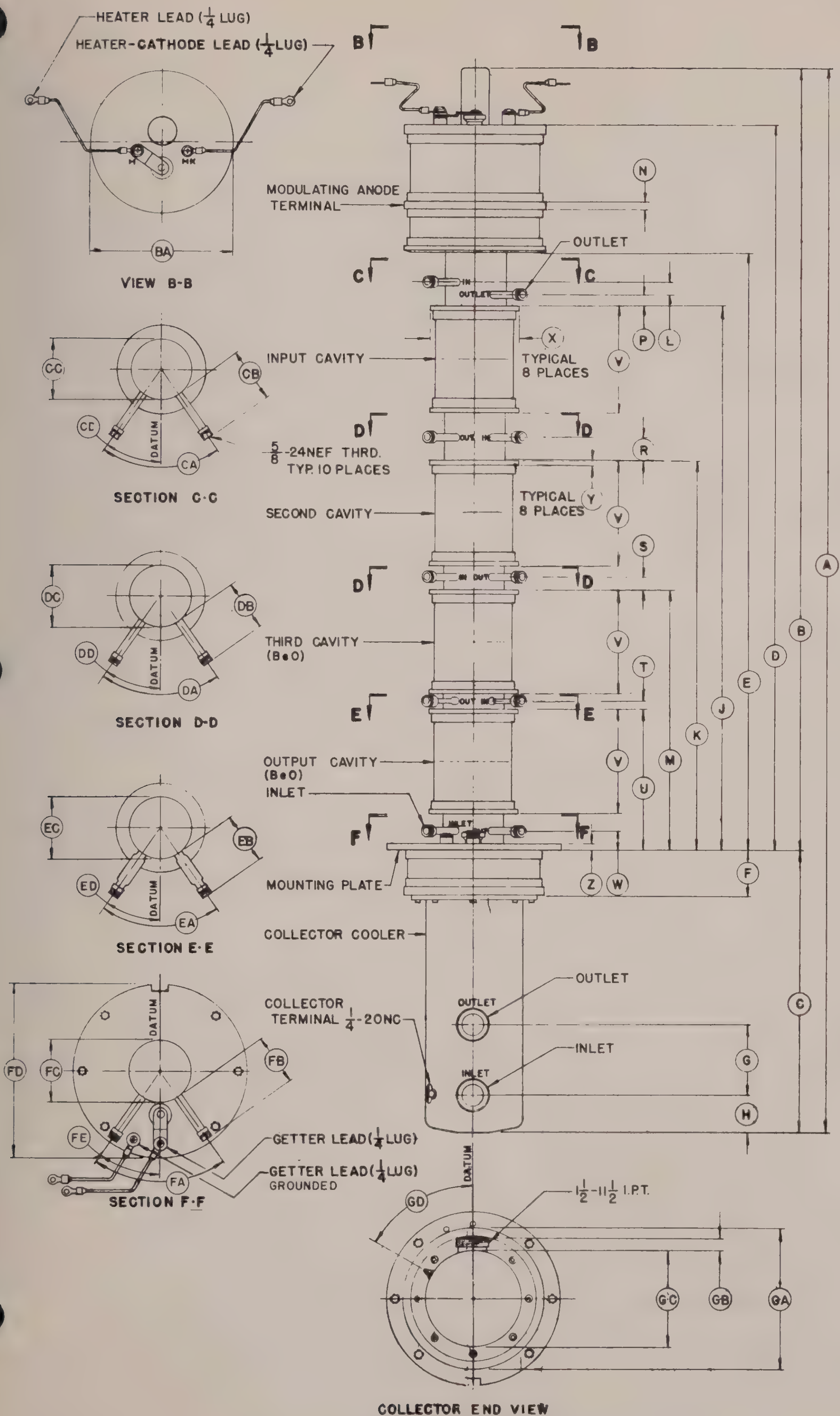
DC BEAM VOLTAGE	17	KILOVOLTS
DC BEAM CURRENT	4.2	AMPERES
DC BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	70	KILOWATTS
INLET WATER PRESSURE	100	PSI

TYPICAL OPERATION

	TV Visual Amplifier	
Frequency	610	megacycles
Output Power	12.5 (peak sync)	kilowatts
Driving Power	14 " "	watts
Power Gain	29.5 " "	decibels
DC Beam Voltage	14	kilovolts
DC Beam Current	3.15	amperes
Beam Power Efficiency	28.5 (peak sync)	percent
1 db Bandwidth	8	megacycles
Electromagnet Current:	8.3	amperes

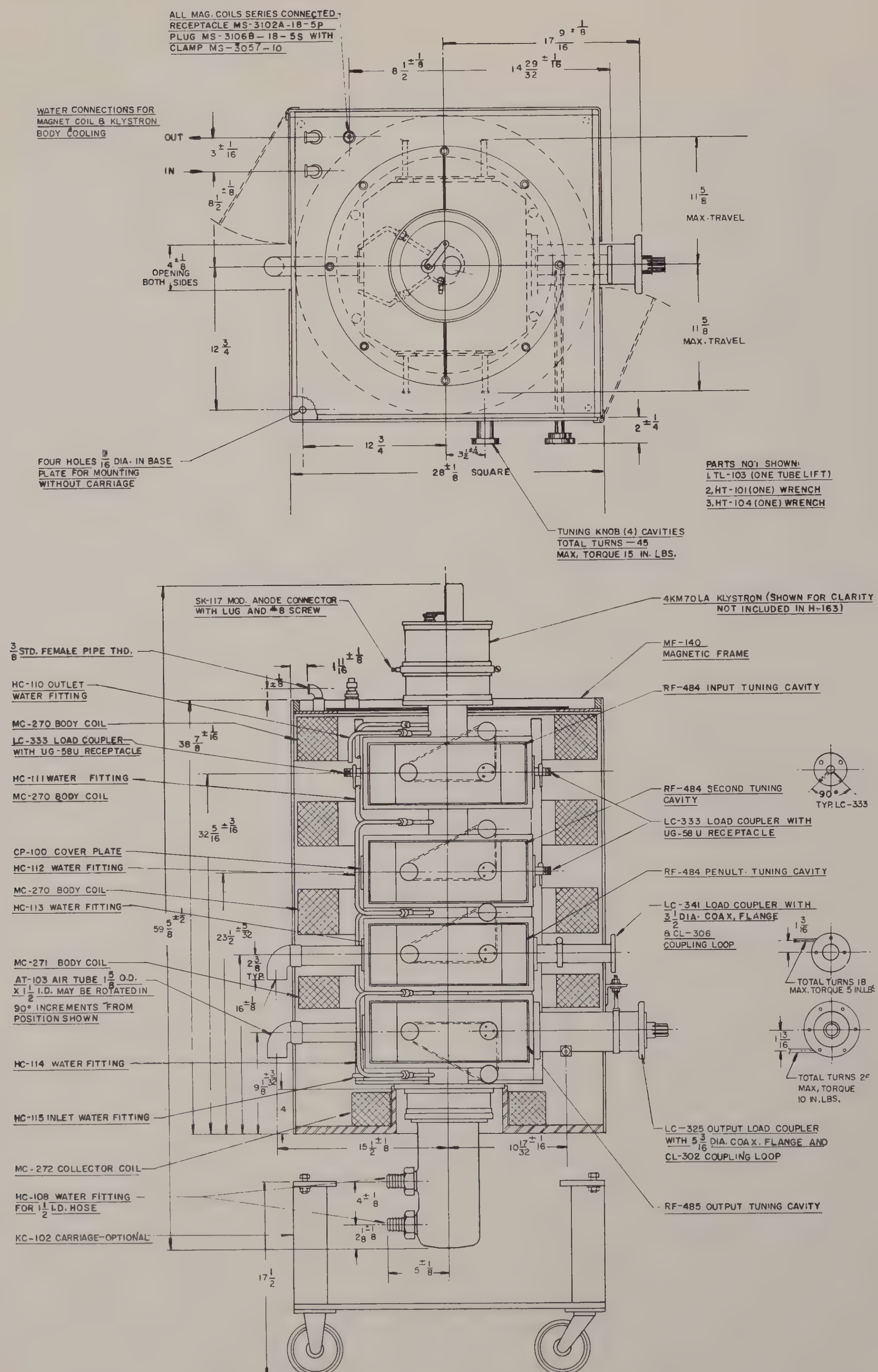
* Required only if ambient air temperature exceeds 25° C.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

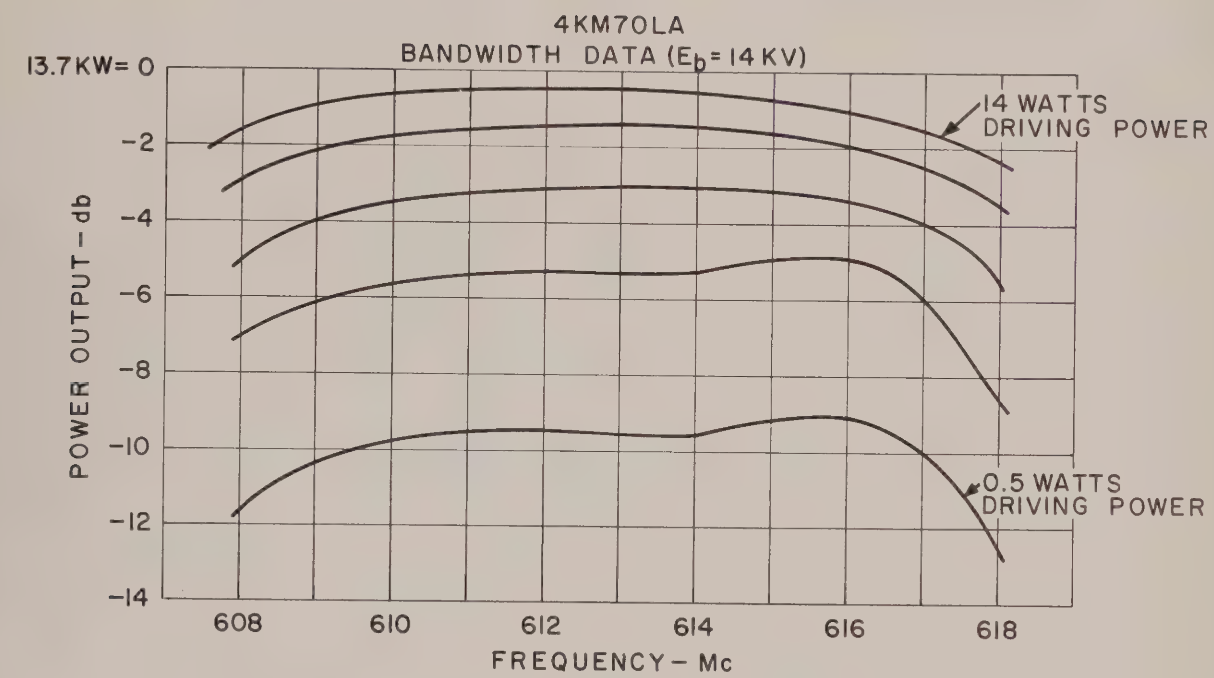


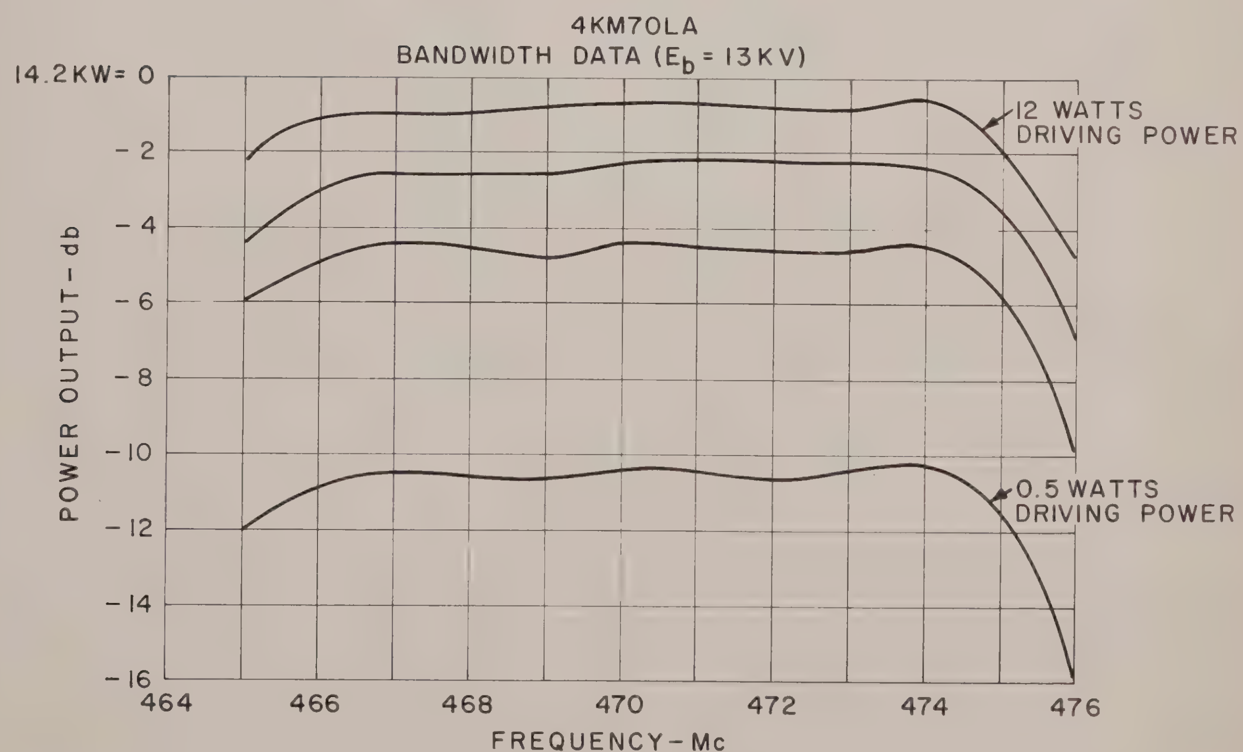
DIMENSION DATA			
REF.	NOMINAL	MINIMUM	MAXIMUM
A	59.625		
B	45.150		
C	14.475		
D	41.900		
E	34.467		
F	2.600		
G	4.000		
H	2.125		
J	31.341		
K	22.499		
L	.625		
M	14.999		
N	.375		
P	.636		
R	1.433		
S	.875		
T	.453		
U	8.124		
V	6.000		
W	1.124		
X	5.125		
Y	.250		
Z	.375		
BA	8.125 DIA		
CA	70°		
CB	3.000		
CC	3.500 DIA		
CD	35°		
DA	70°		
DB	3.000		
DC	3.500 DIA		
DD	35°		
EA	70°		
EB	3.000		
EC	3.500 DIA		
ED	35°		
FA	70°		
FB	3.000		
FC	3.500 DIA		
FD	10.000 DIA		
FE	35°		
GA	8.125 DIA		
GB	.843		
GC	5.500 DIA		
GD	60°		

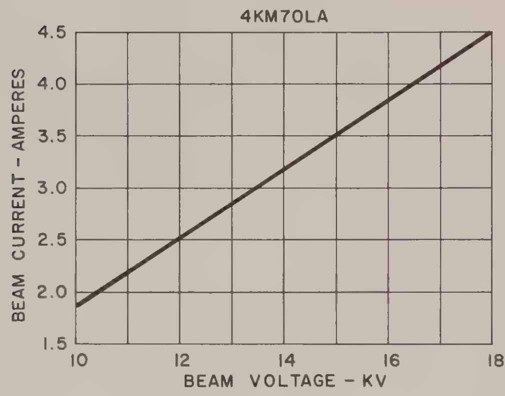
4KM70LA KLYSTRON

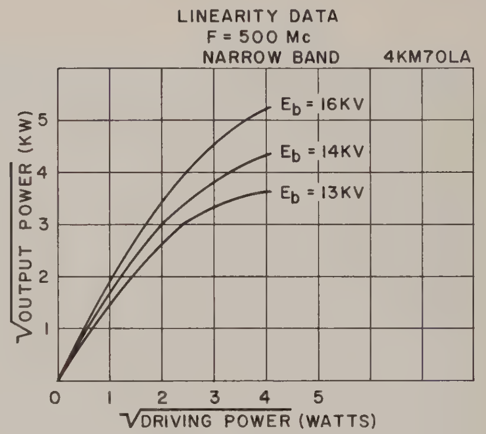


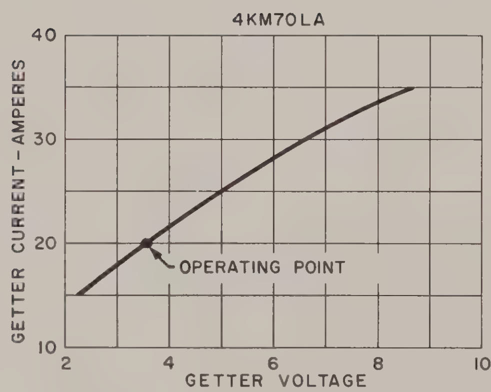
H-163 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

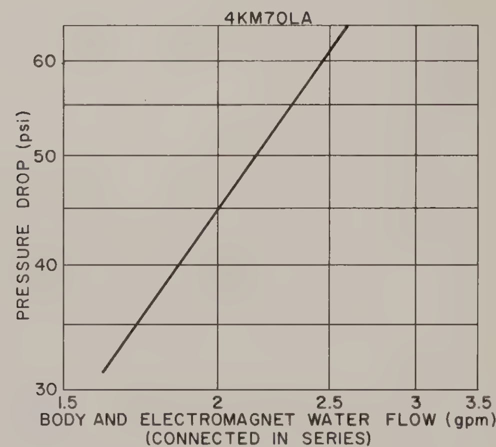

4KM70LA
BANDWIDTH DATA (E_b = 14 KV)
13.7 KW = 0
-2
-4
-6
-8
-10
-12
-14
POWER OUTPUT - db
608
610
612
614
616
618
FREQUENCY - Mc
14 WATTS DRIVING POWER
0.5 WATTS DRIVING POWER

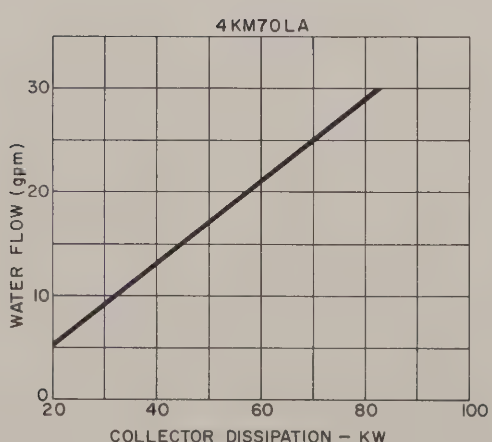

4KM70LA
BANDWIDTH DATA (E_b = 13 KV)
14.2 KW = 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16
POWER OUTPUT - db
464
466
468
470
472
474
476
FREQUENCY - Mc
12 WATTS DRIVING POWER
0.5 WATTS DRIVING POWER

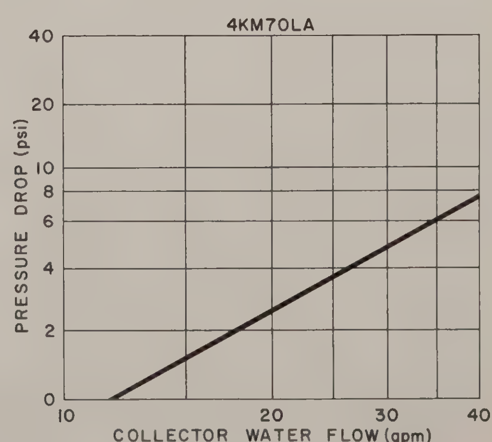

4KM70LA
4.5
4.0
3.5
3.0
2.5
2.0
1.5
BEAM CURRENT - AMPERES
10
12
14
16
18
BEAM VOLTAGE - KV


LINEARITY DATA
F = 500 Mc
NARROW BAND
4KM70LA
E_b = 16KV
E_b = 14KV
E_b = 13KV
$\sqrt{\text{OUTPUT POWER}}$ (KW)
1
2
3
4
5
0
1
2
3
4
5
$\sqrt{\text{DRIVING POWER}}$ (WATTS)


4KM70LA
40
30
20
10
GETTER CURRENT - AMPERES
OPERATING POINT
2
4
6
8
10
GETTER VOLTAGE


4KM70LA
60
50
40
30
PRESSURE DROP (psi)
1.5
2
2.5
3
3.5
BODY AND ELECTROMAGNET WATER FLOW (gpm)
(CONNECTED IN SERIES)


4KM70LA
30
20
10
0
WATER FLOW (gpm)
20
40
60
80
100
COLLECTOR DISSIPATION - KW


4KM70LA
40
20
10
8
6
4
2
0
PRESSURE DROP (psi)
10
20
30
40
COLLECTOR WATER FLOW (gpm)

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Tentative Data

X841D

PULSE AMPLIFIER

UHF KLYSTRON

The EIMAC X841D is a pulse amplifier klystron designed for broadband high average power pulse service at frequencies from 400-450 megacycles. This klystron will have a 5%, fixed-tuned band-width anywhere within this frequency range and will deliver a minimum peak output power of 2.5 megawatts, at 150 kilowatts average power, with a minimum power gain of 33 decibels.

Six integral cavities are used in the klystron. The output circuit mates to a 6⅛ inch transmission line.

This klystron employs the EIMAC Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. The electron-gun geometry is such that a typical switching voltage of 75 kilovolts is required for the modulating anode to provide the specified beam current, at the rated beam voltage of 115 kilovolts. The equivalent modulating anode impedance is approximately one megohm.

The tube incorporates a built-in ion pump and gauge which maintains a low gas pressure, and also provides a means for continuously monitoring this pressure.

Catalog Number H-150 has been assigned to the magnetic circuitry for this tube.

CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	15 minutes
Heater: Voltage (maximum)	30 volts
Current (maximum)	35 amperes
Power Gain (minimum)	33 decibels
Peak Power Output	2.5 megawatts
Average Power Output	150 kilowatts
Phase shift as a function of beam voltage	0.006 degree/volt
Ion Pump: Voltage	3,000-4,000 volts dc
Current (0.1 megohm limiting resistor)	10 milliamperes
Beam Microperveance	1.6
Electron Gun Microperveance	3.0

MECHANICAL

Operating Position		Vertical, Cathode End Down
Input Coupling (rf)		UG 22/U, Type N
Output Coupling (rf)		6⅛″ Coax
Approximate Weight (tube only)		1,000 Pounds
Approximate Weight (H-150 Magnetic Circuit)		1,200 Pounds
Cooling: Oil and Water (Max Water Inlet Temp of 45°C)		
Cathode — Immersed in Oil	*Flow Rate*	*Pressure Drop*
Collector	120 gpm	65 psi
Klystron Body	10 gpm	65 psi
Electromagnet	5 gpm	65 psi
Maximum Overall Dimensions (Klystron and Electromagnet):		
Length		130 inches
Diameter		26 inches
Greatest Extending Radius		16-5/16 inches

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Each of 3 supplies	75 volts at 10 amperes
Each of 2 supplies	150 volts at 10 amperes
Each of 3 supplies	300 volts at 10 amperes

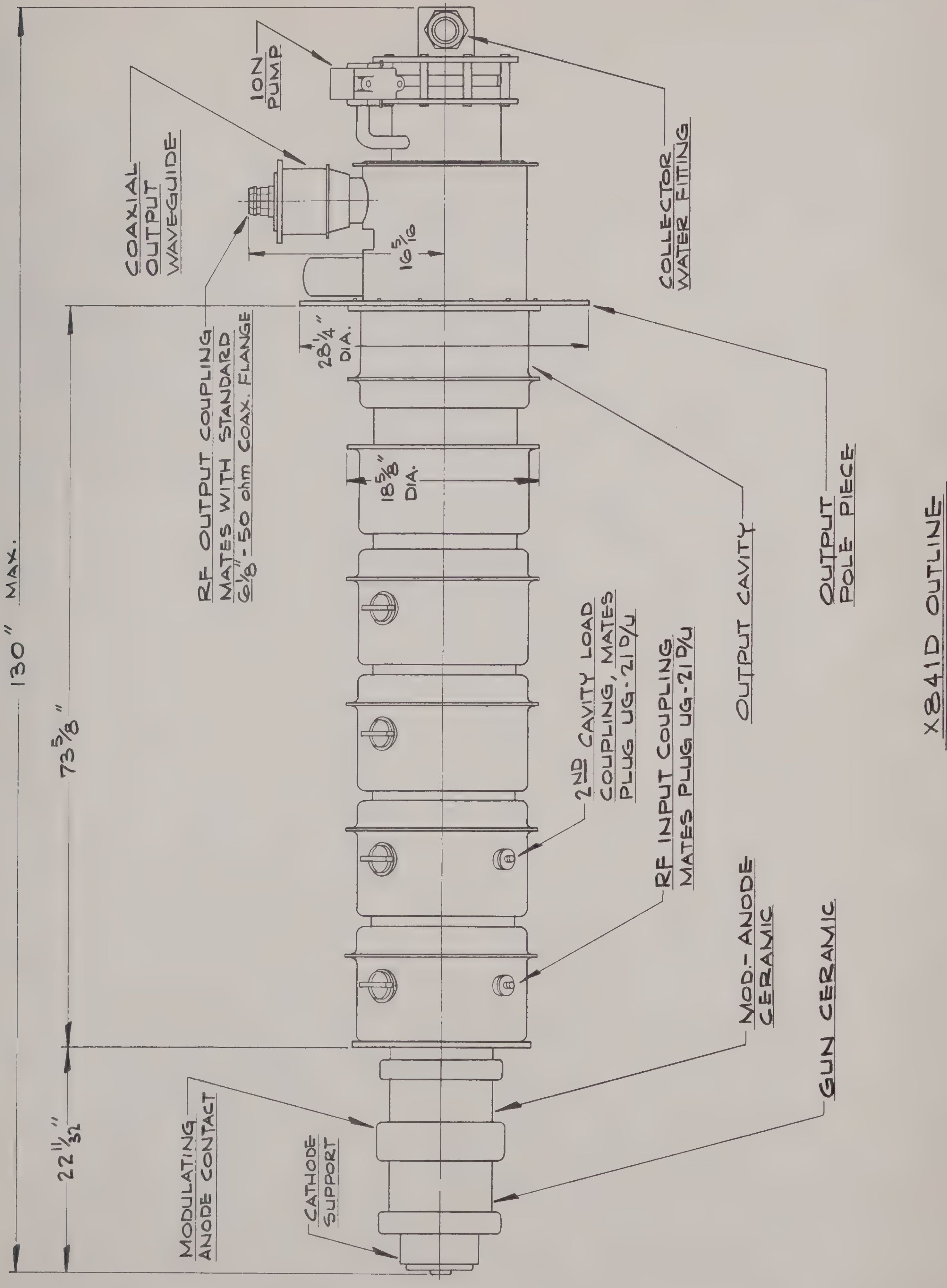
MAXIMUM RATINGS

BEAM VOLTAGE (dc)	115 Kilovolts
PEAK BEAM CURRENT	66 Amperes
PEAK MODULATING ANODE VOLTAGE	78 Kilovolts
AVERAGE MODULATING ANODE CURRENT	20 Milliamperes
AVERAGE BODY CURRENT	200 Milliamperes
PULSE WIDTH	2000 Microseconds
COLLECTOR DISSIPATION	450 Kilowatts
DUTY CYCLE	.06
SEAL TEMPERATURES	150 Degrees C
LOAD VSWR	1.5:1
INLET WATER PRESSURE	100 PSIG

TYPICAL OPERATION, BROAD-BAND PULSE AMPLIFIER

Center Frequency	425 Megacycles
Beam Voltage	112 Kilovolts dc
Peak Modulating-Anode Voltage	74 Kilovolts
Peak Beam Current	60 Amperes
Average Body Current	60 Milliamperes dc
Peak Output Power	2.5 Megawatts
Average Output Power	150 Kilowatts
Peak Drive Power	500 Watts
Power Gain	37 Decibels
Peak Beam Power Efficiency	40 Percent
Pulse Width	2000 Microseconds
Pulse Repetition Rate	30 Pulses per second
Duty	.06
Bandwidth (1 db)	25 Megacycles
Load VSWR	1.2:1

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.



X841D OUTLINE

EITEL-McCULLOUGH, INC.

EM15LS

INDUSTRIAL MAGNETRON

25 kW
915 Mc.

The Eimac EM15LS is a rugged power magnetron designed specifically for industrial processing. It is designed to operate in the industrial and scientific frequency allocation of 915 ±15 Mc. A power output of 25 kW can be obtained into a matched load at an efficiency of approximately 80%. Long operating life in severe industrial environment is assured through use of a directly heated pure tungsten spiral cathode. Further, ruggedness is assured through exclusive use of metal-ceramic construction. Every effort has been made in the design of this tube to keep water cooling pressure and purity requirements down to minimize cooling cost. The magnetic field is provided by an electromagnet which is an integral part of waveguide coupler Type H-195. This coupler mates with 9¾" x 4⅞" waveguide.

The magnetron may be operated with a fixed magnetic field or with the electromagnet connected in series with the anode. The latter mode of operation greatly reduces the variation in output power due to supply voltage changes.

Anode voltage for the EM15LS is normally supplied from a full wave three-phase rectifier with or without filter choke. The degree of filtering in any particular application is dictated by the permissible amplitude and frequency modulation of the rf output power. These are mainly determined by the anode current ripple.

CHARACTERISTICS

ELECTRICAL

Filament:	
Heating Time	10 seconds
Starting Voltage (±5%)	13 volts ac
Starting Current	115 amperes ac
Maximum Inrush Current	250 amperes
Cold Resistance	0.03 ohms
Output Power	25 kilowatts
Frequency	915 ±15 Mc

MECHANICAL

Maximum Dimensions:	
Length	17 inches
Diameter	7 inches
Weight	25 pounds
Output Coupling (rf)	(See outline drawing)
Mounting Position Preferred	Vertical

Cooling: Water and Forced Air	*Flow Rate*	*Pressure Drop*
Anode	3 gpm	30 psi
Electromagnet	0.25 gpm	30 psi
Output Window	20 cfm	2" H_2O
Stem	5 cfm	2" H_2O

POWER SUPPLY REQUIREMENTS

Electromagnet Voltage, dc	50 volts
Electromagnet Current, dc	4 amperes
Filament Voltage, ac	14 volts
Filament Current, ac	120 amperes

MAXIMUM RATINGS

Anode Voltage (dc)	14 kilovolts
Anode Current (dc)	3 Amperes
Anode Dissipation	15 Kilowatts
Load VSWR	2.5:1
Seal Temperature	175°C
Water Outlet Temperature	70°C

TYPICAL OPERATION

Frequency	915	915	megacycles
Output Power	20	25	kilowatts
Anode Voltage	11.5	12.5	kilovolts dc
Anode Current	2.1	2.4	amperes dc
Efficiency	83	83	percent
Filament Voltage	11	10.8	volts ac
Filament Current	106	103	amperes ac
VSWR	3:1*	2.5:1*	
Electromagnet Current	3.3	3.6	amperes dc

*Efficiency with mismatched load depends upon phase angle of the load. Efficiencies listed can be obtained with matched load or at selected phase angles.

NOTES

1. COOLING

Both air and water cooling must be applied before anode voltage is applied.

2. FILAMENT ADJUSTMENTS

Before the anode voltage is applied, the filament current must be set for 115 amperes and held there for 10 seconds. When the magnetron begins operating, the heater current should be reduced immediately to compensate for back bombardment. The filament current given above is for a matched rf load. Maximum life of this magnetron will be obtained if the filament voltage is decreased during operation until the filament resistance V_f/I_f is the same as that when the magnetron is not oscillating; i.e., V_{fo}/I_{fo}. When the rf load is reasonably constant in magnitude and phase, filament voltage and current can be reduced a fixed amount using manual switch control. However, when the variation of the load mis-match and phase is considerable, more accurate compensation should be provided by automatic control.

3. POWER SUPPLY

The short circuit characteristics of the anode supply must be such that the peak anode current is limited to 25 amperes in case of an arc in the magnetron. If the leakage reactance of the transformer, plus the resistance of the rectifiers, transformer and filter choke do not provide this degree of current limiting, a series resistor is recommended in the anode supply to achieve the additional current limiting required.

4. OPERATION WITH SERIES FIELD

With the coil of the electromagnet connected in series with the anode as shown in Fig. 4, the magnetron threshold voltage V_T (approx. equal to the anode voltage at zero anode current, see Fig. 3) becomes proportional to the anode current and curve of V_a against I_a for steady currents, and is obtained as given in Fig. 5. The slope of this characteristic, which depends upon the number of turns in the coil, is much greater than that with fixed field (compare with Fig. 3), and

hence the power changes with supply voltage variations are correspondingly reduced. This is one advantage of the series field mode of operation.

Operating points to the left of the line can be reached by supplying a biasing current through the coil. Assuming an initial biasing current, the behavior is then as follows: as the anode voltage, and hence current, rises from zero, the increasing voltage drop across the magnet coil causes a decrease in the biasing current, and a $V_a I_a$ characteristic of reduced slope* is obtained. Beyond the branch point shown in Fig. 5, the biasing current is zero and full series field behavior is obtained. The characteristic is raised or lowered in accordance with the biasing current and threshold voltage V_T, and with a fixed supply voltage this enables the power output to be controlled in an economical way by varying the magnet current. Since the slope of the characteristic depends upon the magnet coil resistance, there is a slight drift of the operating point as the coil warms up. This can be minimized by making R_b large compared with R_m or by using a bias supply which behaves as a constant current source.

With series field, anode voltage cannot be applied instantaneously without biasing field current, because a transient voltage approximately equal to the anode supply voltage is developed across the magnet coil. A recommended method of starting is therefore to increase the biasing current to raise V_T above the no load voltage of the anode supply, switch on the anode voltage, and then reduce the biasing current until the required operating point is reached.

With series field, the stability against load mismatch remains the same as that with fixed field, but the variation in anode impedance V_a/I_a, with phase of load VSWR is reduced by a self-regulating action. This leads to a power variation (see Fig. 2 for example) which is mainly determined by efficiency changes.

Precautions should be taken to prevent excessive load reflection as stipulated in the maximum ratings, since operation in unwanted modes is always possible with series field, following a cessation of oscillation in the proper mode.

5. INSTALLATION

The EM15LS is constructed from metal and ceramic. Reasonable care should be taken to protect the tube from excessive shocks when handling and after installation. The mounting position is with axis vertical, either up or down.

Connection between the magnetron and the H-195 is made by a copper washer retained on a flange on the tube at the base of the dome window. The tube must be seated squarely in the electromagnet, and the retaining screws tightened up uniformly to ensure proper contact at the washer. A new washer should be used each time the magnetron is inserted. A new washer is supplied with each new tube purchased.

The magnetron dome window is forced-cooled by air ducted over the dome by a flanged insulating cylinder. To obtain proper cooling it is necessary to ensure a uniform gap between the cylinder and dome.

The cathode terminals must be securely clamped to make proper contact and avoid overheating. Cooling is by forced air through a duct attached to the small cathode terminal. The terminal temperature should not exceed 175°C.

*In proportion to $\frac{R_b}{R_b+R_m}$, where R_b is the effective internal impedance of the biasing supply, and R_m the magnet resistance.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

ELECTROMAGNET CHARACTERISTIC

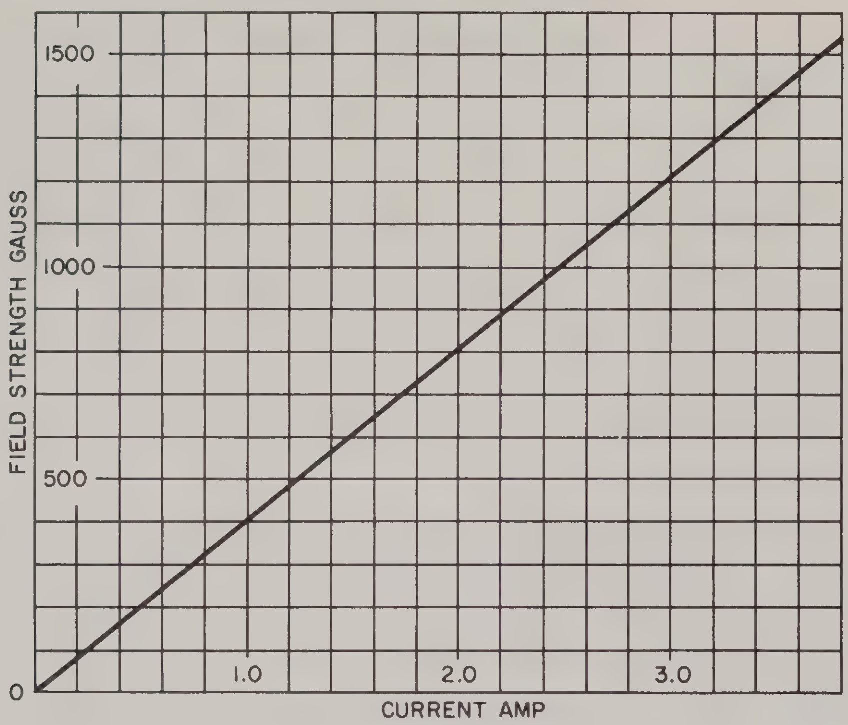
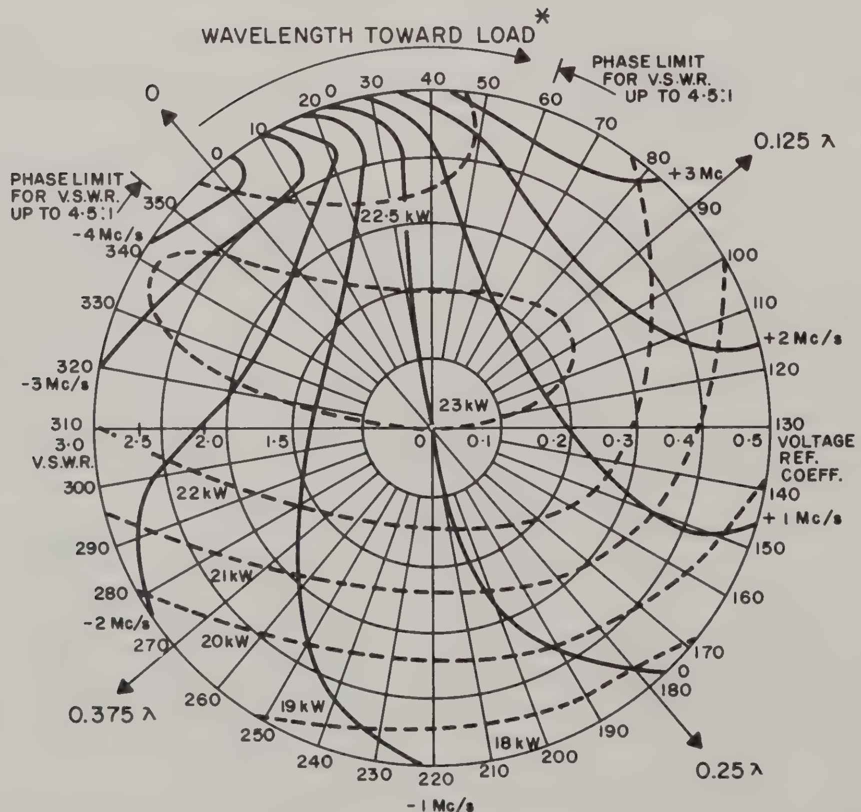


fig. 1



TYPICAL RIEKE DIAGRAM

fig. 2

Va = 12.5 kv
Ia = 2.4 a
f = 915 Mc

*ZERO WAVELENGTH IS AT FLANGE OF LAUNCHER AND INDICATES VOLTAGE MINIMUM AT THE FLANGE.

PERFORMANCE CHART

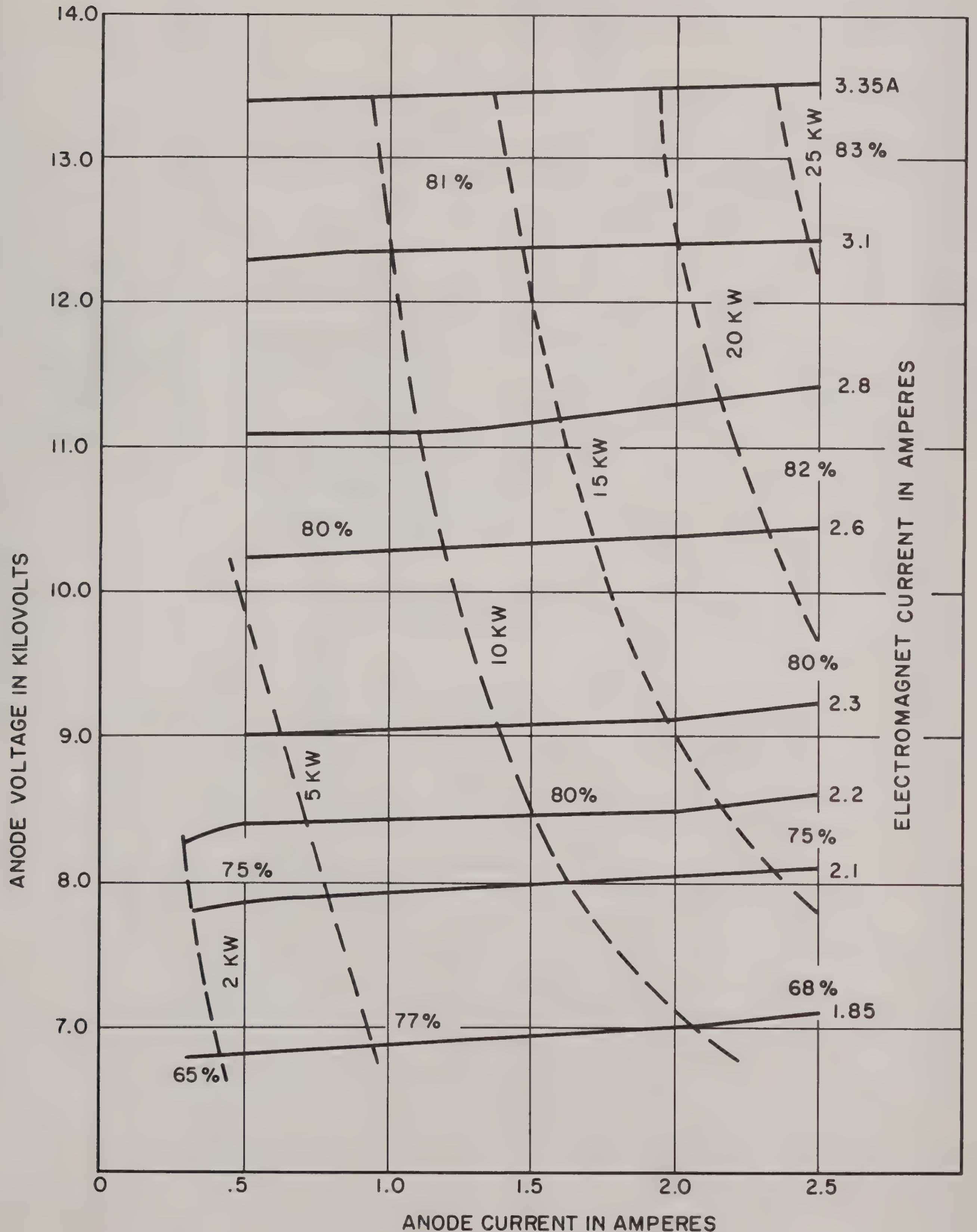
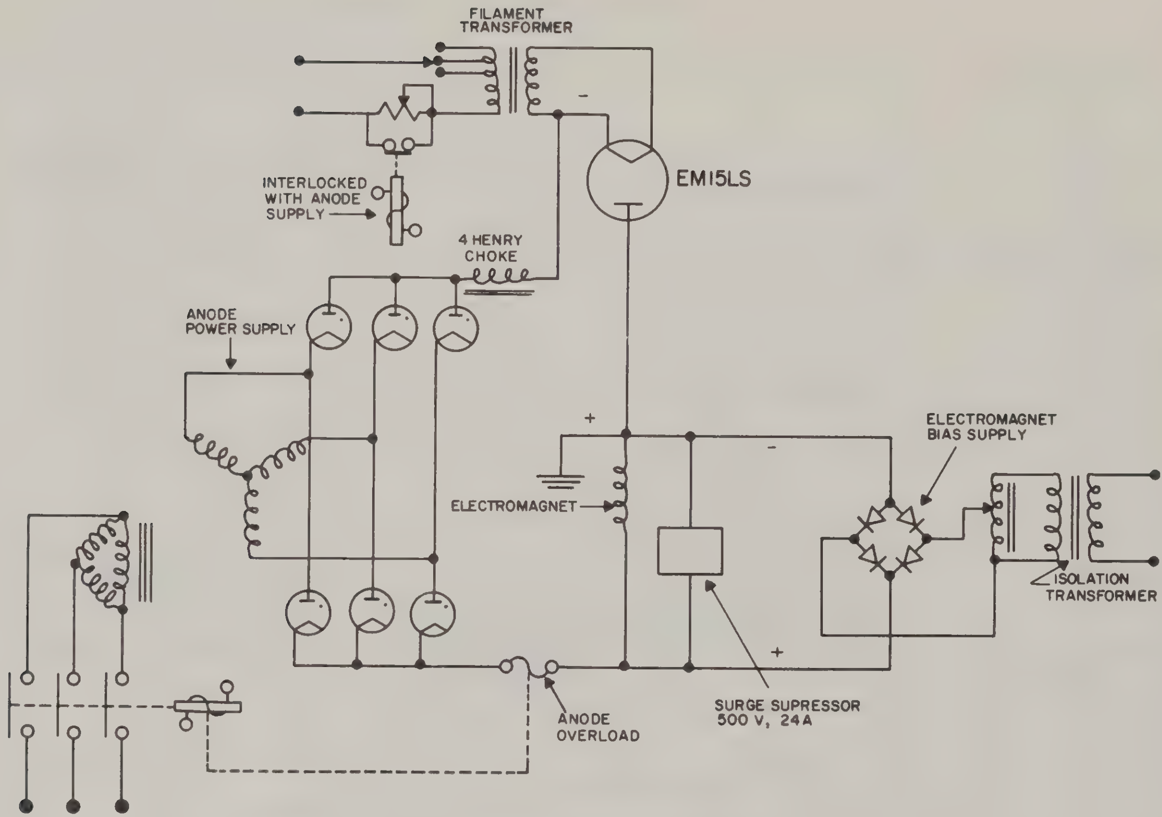


fig. 3



ELEMENTARY CIRCUIT FOR OPERATION WITH SERIES FIELD
fig. 4

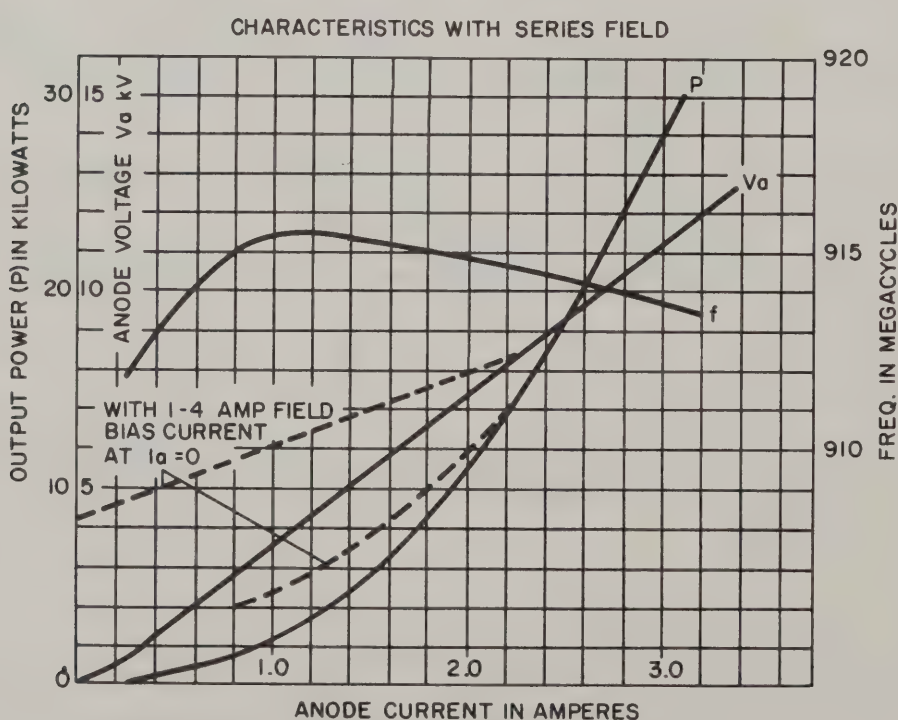
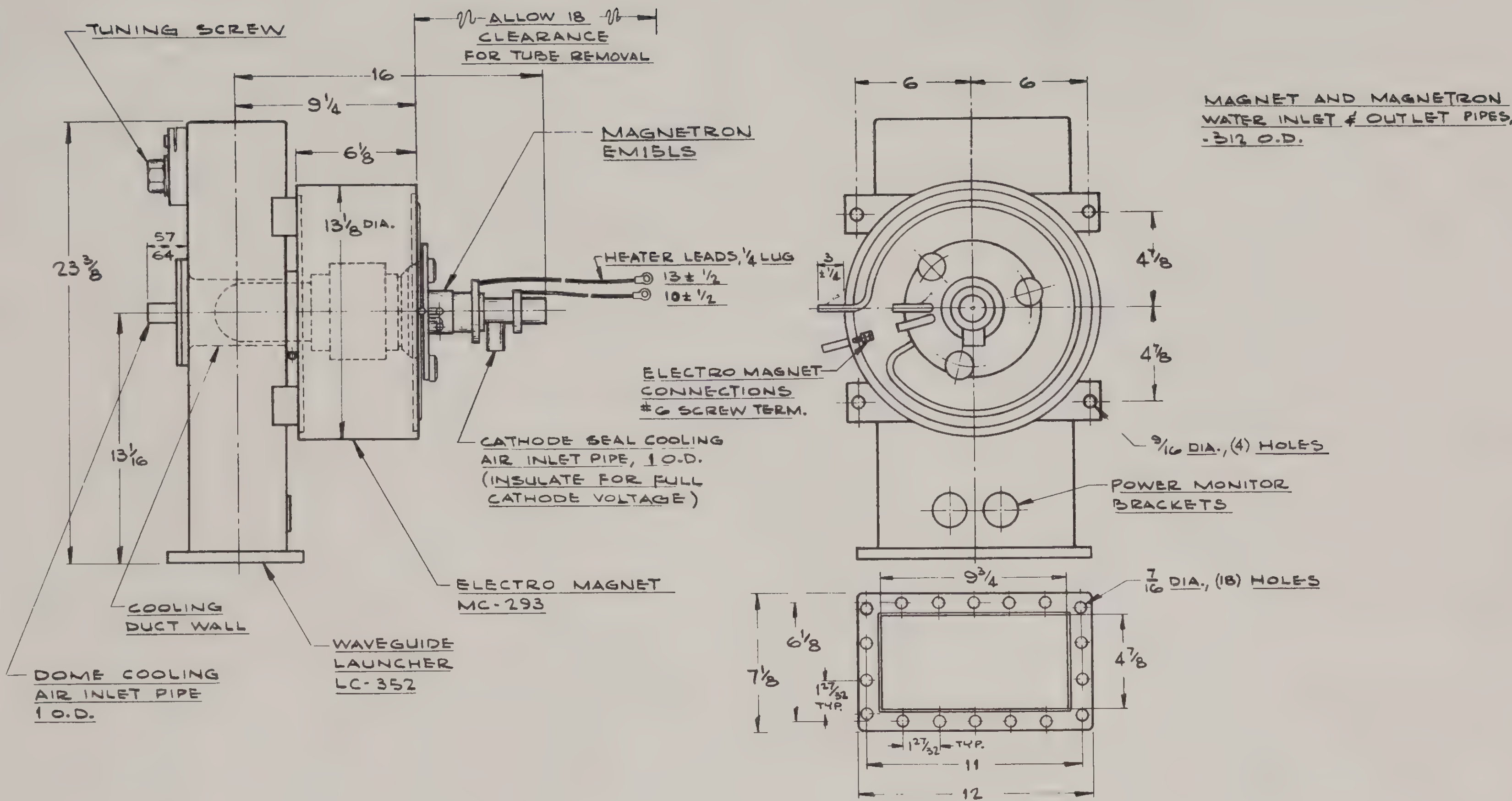
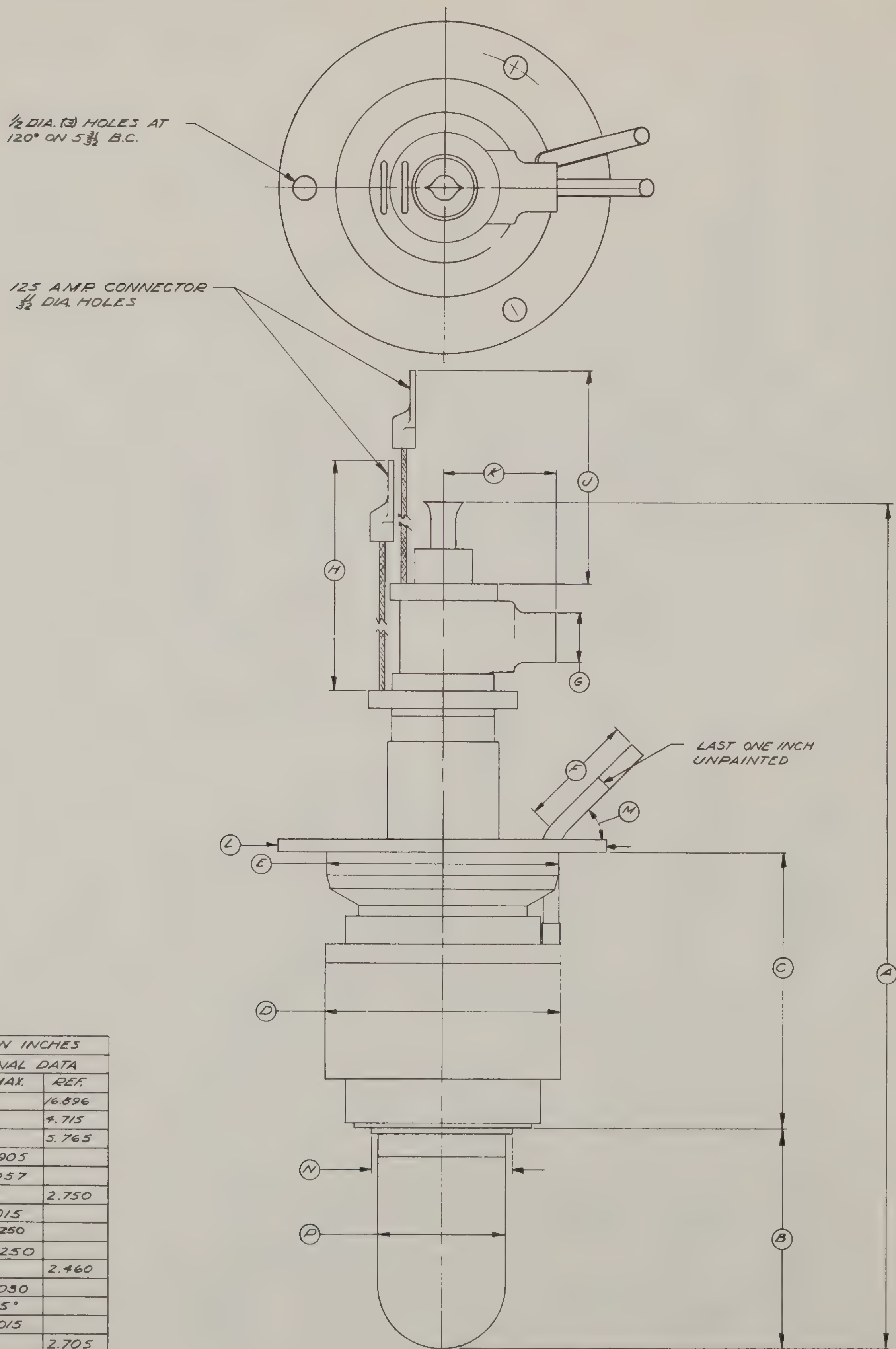


fig. 5



EM-15LS MAGNETRON AND H-195 WAVEGUIDE COUPLER



DIMINSIONS IN INCHES			
DIMINSIONAL DATA			
DIM.	MIN	MAX.	REF.
A			16.896
B			4.715
C			5.765
D	4.855	4.905	
E	4.917	4.957	
F			2.750
G	.985	1.015	
H	10.500	11.250	
J	12.500	13.250	
K			2.460
L	6.970	7.030	
M	25°	45°	
N	2.985	3.015	
P			2.705

EM15LS MAGNETRON

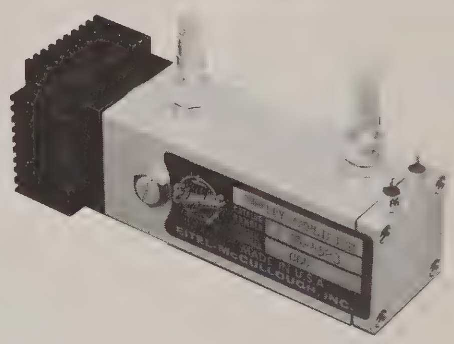
Eimac® EITEL-McCULLOUGH, INC.

Tentative Data

X4576

CAVITY AMPLIFIER

2300-2600* Mc
20 Watts CW



The X4576 cavity amplifier is recommended for use in airborne and ground transmitters. It is a compact, lightweight, high efficiency amplifier using a ceramic-metal planar triode. It will withstand the severe environmental conditions of missile and aircraft operation. Field tuning is simple.

A recommended dc-dc converter for use with this unit is Eimac Model EM4590.

CHARACTERISTICS

ELECTRICAL

Frequency,* continuously tunable	2300-2450 Mc 2450-2600 Mc
rf Power Output (2 watts drive), at 2300 Mc	20 watts
2450 Mc	18 watts
2600 Mc	15 watts
Bandwidth, Minimum, 3 db points	5 Mc
Gain, Minimum, 2300 Mc	10 db
2600 Mc	8 db
Load Impedance, Nominal	50 Ohms
VSWR, Maximum, for full rated output (fixed phase)	1.5:1
without damage	3:1
Power Supply Requirements	
Anode Voltage, Maximum	800 Volts
Current, Maximum	125 mA
Heater Voltage	6.0 Volts
Current	1.0 Amperes
Warm-up Time	3 minutes

MECHANICAL

Size (excluding protrusions), maximum	1¼" x 1¼" x 4⅜"
Weight	1.2 Pounds
Mounting	To heat sink (not included)
Tuning Controls	Four (two for coupling, two for frequency)
Cooling	Conduction to heat sink at –40°C to +85°C
Connectors	Type OSM, Female

ENVIRONMENTAL

Temperature, heat sink, for continuous operation	–40°C to +85°C
Altitude	0 to 20,000 feet
Vibration	10 g, 5-500 cps, 15 minutes in 3 mutually perpendicular planes
Shock	15 g for 11 milliseconds in 3 mutually perpendicular planes

*Factory-adjusted for tuning range of 2.3-2.45 Gc or 2.45-2.6 Gc.

EITEL-McCULLOUGH, INC.

EM4577

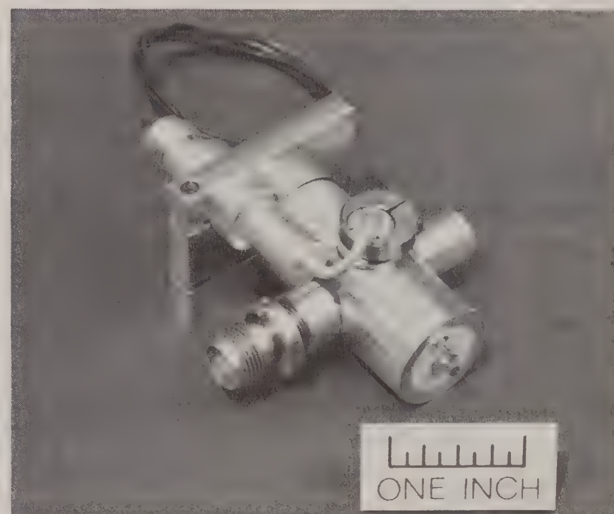
CAVITY OSCILLATOR

1700-1850* Mc

The Eimac EM4577 is an ultra-stable low noise cavity oscillator designed for use in microwave transmitters. It is unusually compact and rugged. Its high frequency stability over a wide temperature range is a major advantage. This unit uses a ceramic-metal planar triode. Operating life, without tube change, averages over 5000 hours.

Electronic tuning range of ±7.5 Mc is achieved by the varactor diode in the plate circuit. A choke is provided to keep rf off the modulation input lead.

The EM4577 is also offered as part of a complete modulated system, EM4584. The modulator is solid state. It pulses the oscillator at 100 pps to achieve a frequency time output of symmetrical triangular form.



CHARACTERISTICS

ELECTRICAL

Tuning Range, Manual		1700-1850* Mc
Tuning Range, Electronic		±7.5 Mc
rf Power Output		2 watts CW
Frequency Stability		±0.15% from —40°C to +75°C
Power Supply Requirements**	*Voltage*	*Current*
Anode, Maximum	170 V	50 mA
Heater	6.0 V	400 mA
Control Grid	Self Bias	
Linearity, for ±1 Mc Deviation		±1%
for ±2.5 Mc Deviation		±5%
for ±5 Mc Deviation		±10%
for ±7.5 Mc Deviation		±15%
Deviation Sensitivity, Nominal		1 Mc/Volt
Modulation		CW/FM
Load Impedance, Nominal		50 Ohms
Load VSWR, Maximum		1.3:1, Any Phase
Tube Type		Eimac 128631

MECHANICAL

Mounting	Clamps to heat sink cradle
Size	Length: 2.25 inches; Diameter: 0.85 inches
Weight	0.5 pounds
Cooling	Conduction to Heat Sink
Connectors	Type TNC, Female

ENVIRONMENTAL

Temperature (Mounting Surface)	—40°C to +75°C
Altitude	0 to 12,000 ft.

*Factory adjusted for any 50 Mc segment of the 1700-1850 Mc band. Other frequencies available on special order.
**A compact solid state dc-dc converter, Model EM4589, is available for use with this oscillator.

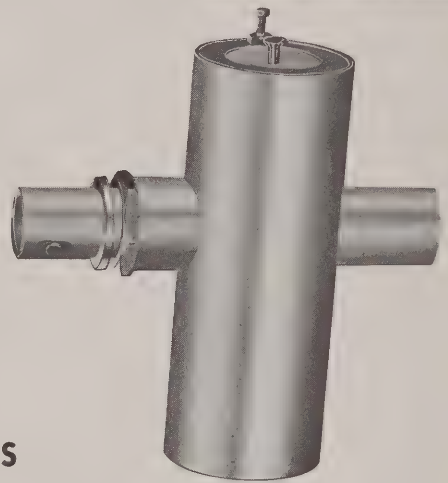
Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4578

CAVITY OSCILLATOR

1000-2000* Mc



The EM4578 is a CW oscillator providing 2 watts rf output at any frequency in the 1-2 Gc band. Specify the required frequency when ordering; we will adjust the EM4578 to this frequency, with field tuning capability of ±10 Mc. This unit is small, lightweight and rugged, using a ceramic-metal planar triode. It is recommended for use in both airborne and ground transmitters.

CHARACTERISTICS

ELECTRICAL

Frequency Range	1000-2000* Mc	
rf Power Output	2** Watts CW	
Frequency Stability	±0.2% from −40°C to +75°C	
Power Supply Requirements:	*Voltage*	*Current*
Anode, Maximum	140 V	50 mA
Control Grid, Maximum		Self Bias
Heater	6.0 V	400 mA
Tube Type	Eimac 128613	
Load Impedance	50 ohms nominal	
Modulation	CW	
VSWR, Maximum	1.3:1, any phase	

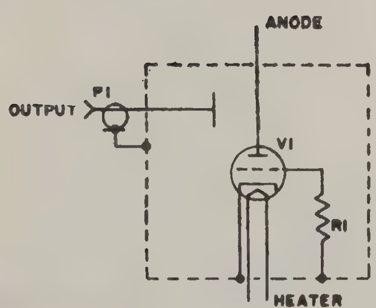
MECHANICAL

Mounting	Clamps to heat sink cradle
Size	Length: 2 to 4 inches, depending on frequency Diameter: 0.85 inches
Weight	0.2 to 0.5 pounds, depending on frequency
Cooling	Conduction
Connector	Type TNC Female

ENVIRONMENTAL

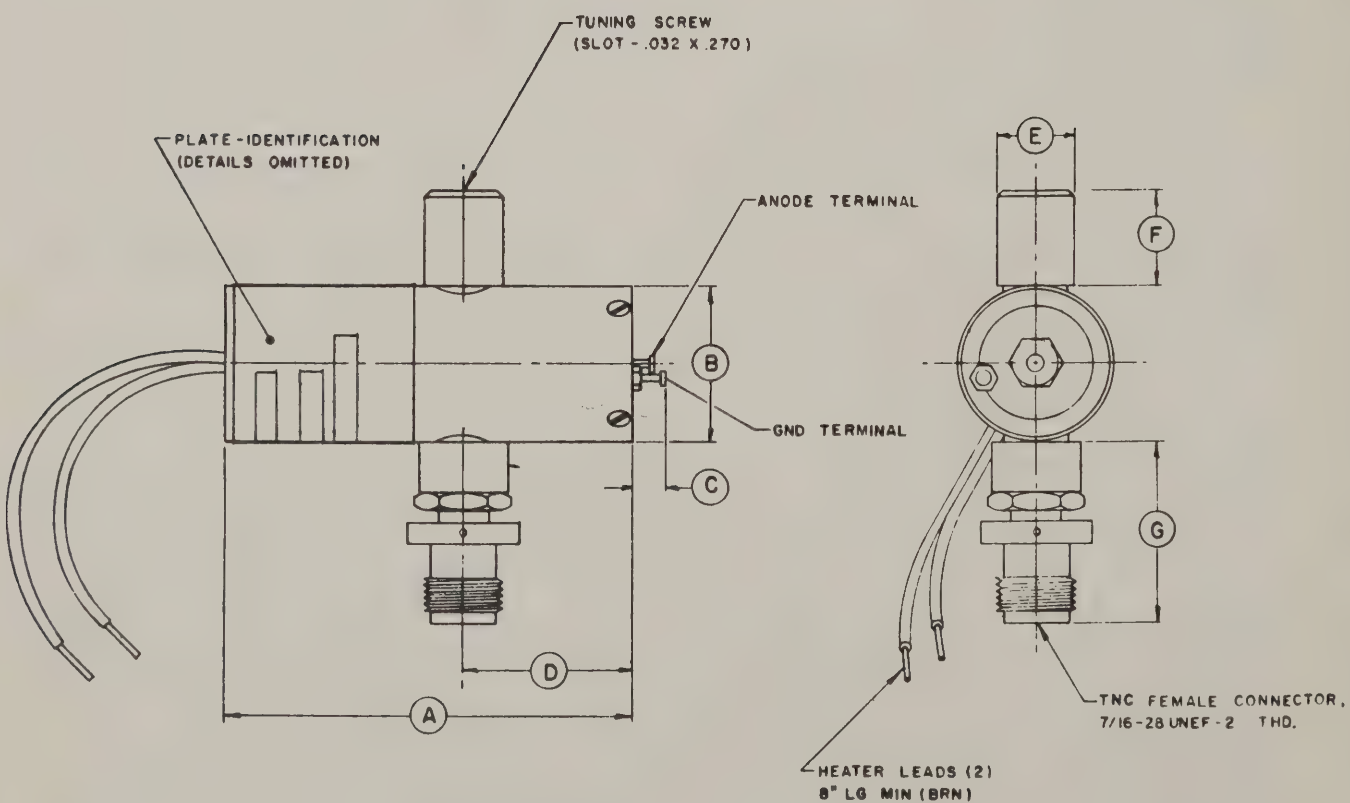
Temperature	−40°C to +75°C
Altitude	0 to 12,000 feet

*Factory adjusted for any 20 Mc Segment of the 1000-2000 Mc band.
**Can provide up to 3 watts output with higher anode voltage and current and special cooling.



SCHEMATIC

FREQUENCY	1000 Mc	1500 Mc	2000 Mc
A (nom.)	4	3	2
D (nom.)	1.75	1.2	.9



Eimac

EITEL-McCULLOUGH, INC.

EM4580

POWER SUPPLY

0-1000V

The Eimac Model EM4580 is a rack-mounted, regulated power supply for laboratory use. Output voltage is continuously variable 0-1000 V at 0.5 Amps; a vernier control permits precise selection of output with less than one volt deviation from the desired value. A 300 Vdc reference output and 6.3 Vac output are also provided. A voltmeter and ammeter are included, accuracy ±2% at full scale. Forced air cooling is provided by the included fan.

CHARACTERISTICS

Output Impedance, Maximum, 0-1000 cps	0.01 Ohm
1-10 Kc	0.1 Ohm
10-100 Kc	1 Ohm
Transient Response	For Full Load/No Load or No Load/Full Load step change, output recovers to within dc regulation limits within 2 milliseconds
Vernier Range	3 Volts
AC Input	105 to 125 Vac rms, 50 to 60 cps, Single Phase
Output Polarity	Swinging link for positive or negative output with respect to ground, or floating output
Overload Protection	Line and HV circuits fused; time delay relay included
Mounting	Fits standard 19″ rack. Also has rubber feet for table mounting
Weight	80 pounds
Dimensions	10½″ high x 19″ x 15″

OUTPUTS:

VOLTS	CURRENT	REGULATION				MAXIMUM RIPPLE mV rms
		Line		No Load/Full Load		
		%	V	%	V	
0-1000 Vdc	0-500 mA	0.02	0.05	0.01	0.02	1
6.3 Vac (CT)	10 A	—	—	—	—	—
300 Vdc	5 mA	0.02	0.05	0.01	0.02	1

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4581 EM4582 EM4583

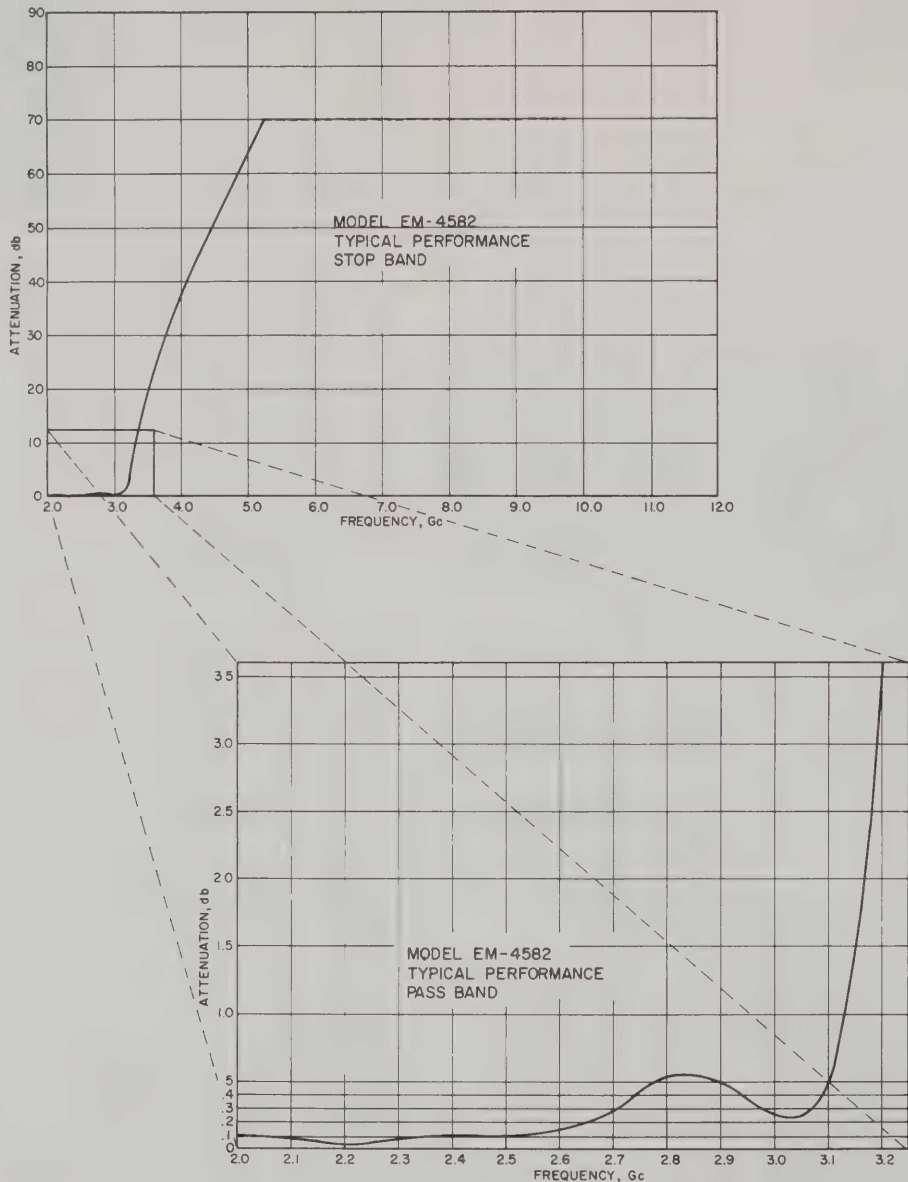
LOW PASS FILTERS

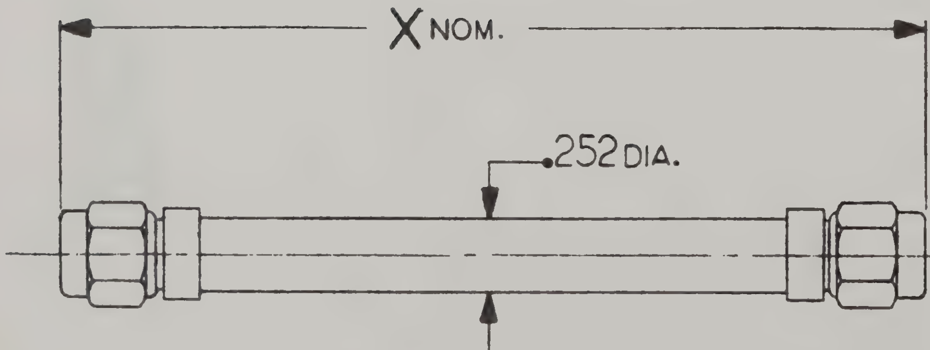
These low pass filters are recommended for use with UHF/Microwave telemetry transmitters, aerospace television transmitters and command/control transmitter exciters. Because of their small size and light weight, however, they are excellent for use in many other low-to-medium power transmitters. Their rugged construction results in reliable performance under the shock and vibration of missile launch. All models are coaxial, multiple-section reactive type filters. Silver plating is used to minimize insertion loss.

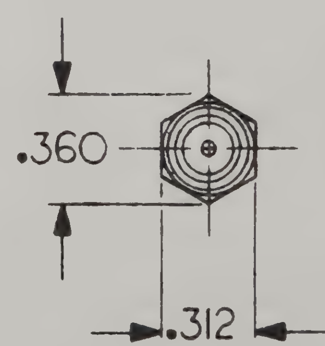
CHARACTERISTICS

MODEL	EM4581	EM4582	EM4583
Pass Band, Mc - - - -	1435-1735	2200-2500	4400-5000
Power Rating, Watts, Avg. - -	100	100	50
Insertion Loss, DB, Max. - -	0.2	0.2	0.2
Attentuation, First Harmonic, DB, Min. - - -	45	45	45
Attenuation, Second and Third Harmonic, DB, Min. -	60	60	60
VSWR, Maximum - - - -	1.2	1.2	1.2
Impedance, Ohms, Nominal -	50	50	50
Connectors (male)[1] - - -	OSM	OSM	OSM

[1]Strip-line connectors also available.







MODEL	EM4581	EM4582	EM4583
X	3.340	2.953	3.279

Eimac

EITEL-McCULLOUGH, INC.

Tentative Data

EM4590

POWER SUPPLY

The Eimac Model EM4590 is a solid state dc-dc converter, recommended for use with 10-30 watt output rf cavity amplifiers and oscillators. It provides regulated plate and heater voltages, operating from 28 Vdc primary source. This is a compact, light weight, high efficiency, conduction-cooled unit. It operates satisfactorily during the shock and vibration of missile launch. It is hermetically sealed, for operation at any altitude.

CHARACTERISTICS

ELECTRICAL

Plate Voltage	600, 650 or 700 Vdc, selectable by internal wiring, at 90 to150 mA
Accuracy, (at nominal input, 125 mA)	±5%
Line Regulation	±5%
Load Regulation	±5%
Ripple (including spikes), maximum	3%
Heater Voltage	5.0 to 6.0 Volts, continuously adjustable, at 0.85 to 0.95 Amperes
Line Regulation	±3%
Load Regulation	±2%
Ripple (including spikes), maximum	10%
Input Voltage	$28\ ^{+8}_{-4}$ Volts dc
Overvoltage, maximum	43 Vdc
Input Transients, maximum	80 volts for 20 microseconds
Input Ripple, Maximum	3 V rms, DC— 20 Kc, superimposed on 24-32 Vdc input
Input reversal is withstood without damage.	
Interference	Meets MIL-I-6181D
Efficiency, Minimum	75%
Life, Continuous or intermittent operation, 95% probability, 60% confidence	1000 hours

MECHANICAL

Size, Overall (excluding connectors)	1.7″ x 4.2″ x 5.5″
Weight	2.5 pounds
Mounting	on 4″ x 5″ surface, to heat sink (not included)
Cooling	Conduction
Pressurization	30 Psia
Connectors: Input	Bendix JT07H-8-3P
Output	Deutsch DTK07H-12—8ARR-P

ENVIRONMENTAL

Temperature (at mounting surface)	—54°C to +95°C
Altitude (3 hour duration)	Any
Vibration	20 g peak, to 2 Kc, Curve E, Fig. 514-3, MIL-STD-810 0.3 G²/cps Random, Curve F, Fig. 514-4, MIL-STD-810
Acceleration (Sustained)	30 g, 5 minutes, three mutually perpendicular axes
Shock	50 g, Method 516, Proc. I, MIL-STD-810 100 g, Sawtooth, Proc. V, MIL-STD-810 Three mutually perpendicular axes

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Tentative Data

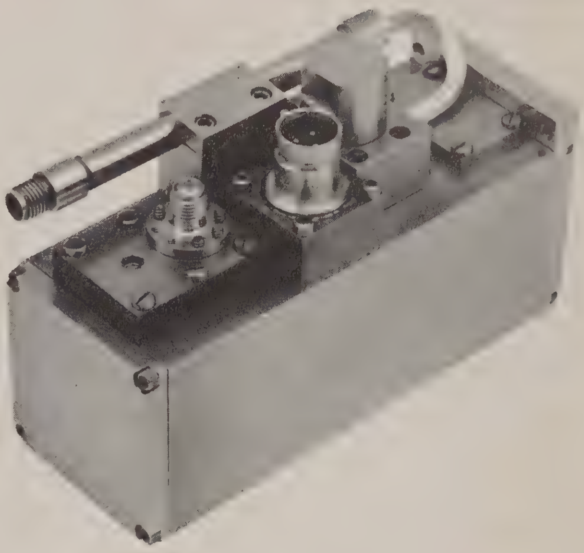
X4592

CAVITY AMPLIFIER

1700-1850 Mc
25 Watts CW

The X4592 cavity amplifier is recommended for use in Aerospace telemetry, television and general-purpose transmitters. It may be used with transmitters having wide modulation bandwidth. Its small size and light weight are major advantages for aerospace use. This unit is hermetically sealed; it may be used at any altitude. It uses a ceramic-metal planar triode. Operation is satisfactory during the severe environmental conditions of missile launch.

A recommended dc-dc converter for use with this amplifier is Eimac Model EM4590.



CHARACTERISTICS

ELECTRICAL

Frequency,[1] continuously tunable - - - - - - - - - - - - 1700-1850 Mc

Rf power[2] output (with 2 watts drive) - - - -

Frequency, Mc	Power output, Watts, CW
1700-1750	20
1750-1800	25
1800-1850	20

Input Signals - - - - - - All standard FM telemetry signal formats, per IRIG 106-60

Bandwidth, Minimum, 3 db points - - - - - - - - - - - - - 10 Mc

Gain, Minimum, 1700-1850 Mc - - - - - - - - - - - - - - 10 db

Load Impedance, nominal - - - - - - - - - - - - - - - 50 ohms

VSWR, Maximum, for full rated output - - - - - - - - - - - - - 1.5:1
without damage - - - - - - - - - - - - - 3:1

Efficiency,[2] Overall, Minimum - - - - - - - - - - - - - - - 25%

Phase jitter, Maximum, between input and output - - - - - - - - - 5° peak

Power Supply Requirements[3]
Anode voltage - - - - - - - - - - - - - - - - 600 Volts
Current - - - - - - - - - - - - - - - - 125 mA
Heater voltage - - - - - - - - - - - - - - - - 5.5 Volts
Current - - - - - - - - - - - - - - - - 1.2 Amperes

Warm-up Time - - - - - - - - - - - - - - - - - 3 Minutes

MECHANICAL

Size, Overall (including protrusions) - - - - - - - - - - - - - - 4" x 2½" x 1½"

Weight - 1.1 pounds

Mounting - - - - - - - - - - - - - - - - To Heat Sink (not included)

Tuning Controls - - - - - - - - - - - - Three (all on same surface)

Cooling - - - - - - - - - - - - Conduction to Heat Sink at –54°C to +95°C

Connectors: rf input - - - - - - - - - - - - - - - - - OSM Female
rf output - - - - - - - - - - - - - - - - - OSM Female
Power - - - - - - - - - - - - - Deutsch #DM 5300-3P-643

ENVIRONMENTAL

Temperature, heat sink, for continuous operation - - - - - - - –54°C to +95°C

Altitude - Any

Vibration - - - - - - - - - - - - - - - 20g, 20-2000 cps, 3 major axes

Other - - - - - - - - - - - - - - - - - - Per MIL-E-5400

FOOTNOTES:

(1) Also available with similar performance characteristics for other frequencies in the 900-2500 Mc range.

(2) Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions.

(3) A separate DC-DC converter package, Model EM4590, operating from 28 +8/–4 Vdc, is available from Eimac. Power supplies for operation from other primary sources are available on special order.

EITEL-McCULLOUGH, INC.

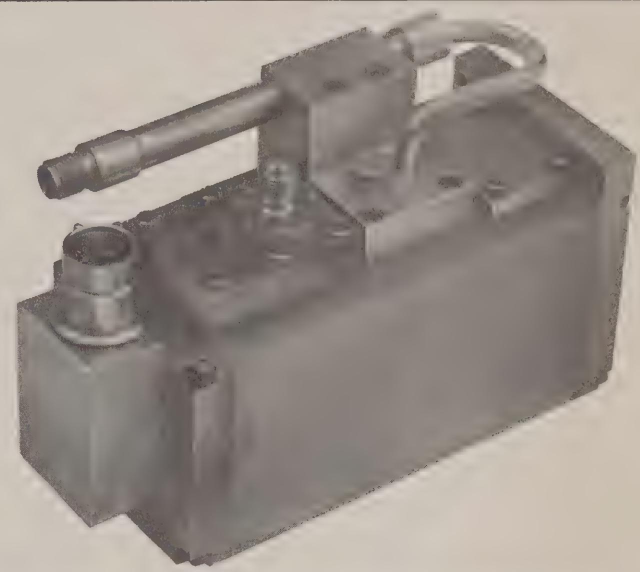
EM4596

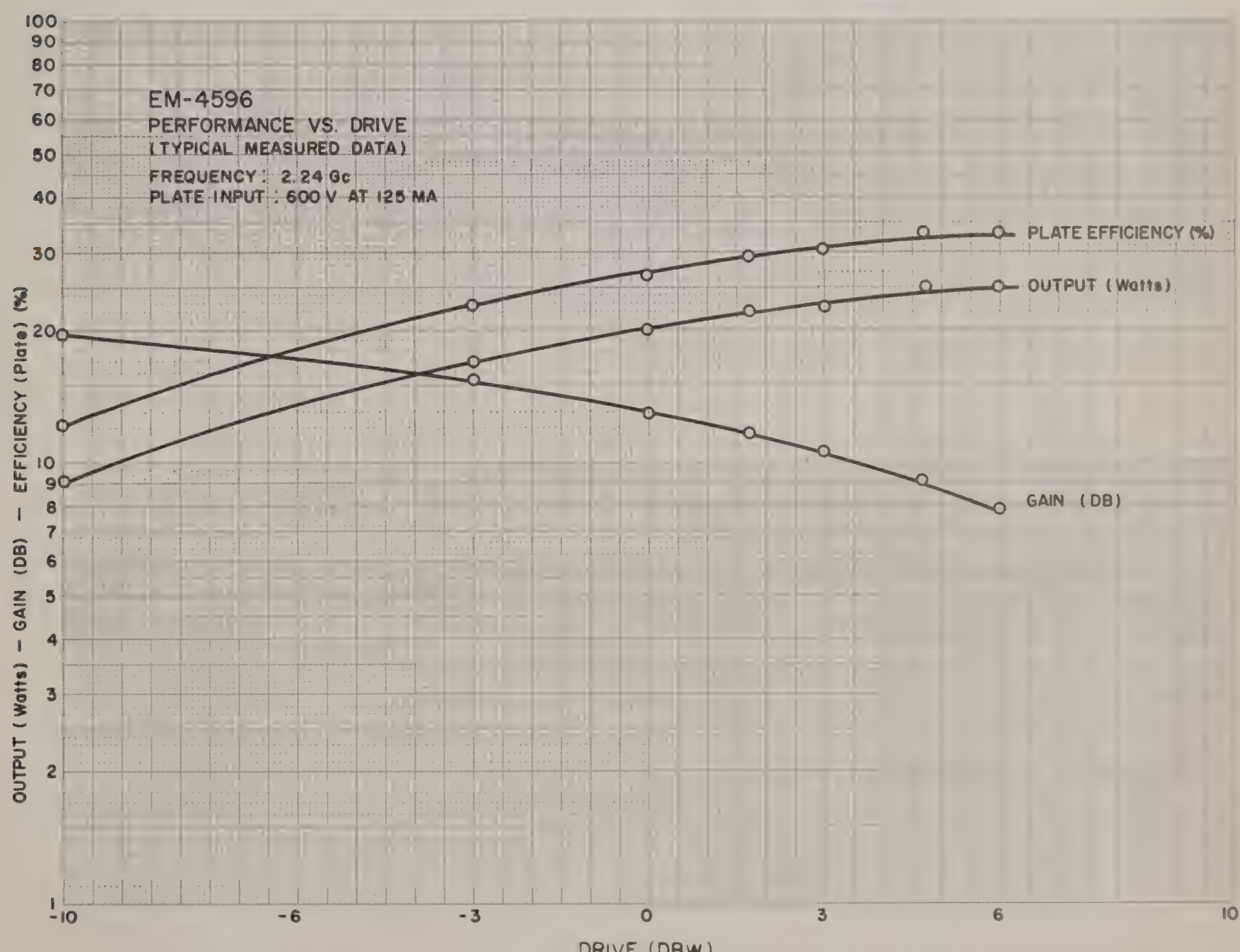
CAVITY AMPLIFIER

2200-2300 Mc

The Eimac EM4596 is a miniaturized 20 watt cavity amplifier incorporating a ceramic-metal planar triode. It is intended for use in aerospace telemetry transmitters and special aerospace transmitters. It is hermetically sealed, for operation at any altitude. All connectors and tuners are accessible on one surface. A low pass filter, for harmonic suppression is included.

A recommended DC-DC converter for use with this amplifier is Eimac Model EM4590.





EM4596 AMPLIFIER

CHARACTERISTICS

ELECTRICAL

Frequency,[1] continuously tunable	2200-2300 Mc
Rf power[2] output (with 2 watts drive)	17 Watts
Input Signals	All standard FM telemetry signal formats, per IRIG 106-60
Bandwidth, Minimum, 3 db points	10 Mc
Gain, Minimum	10 db
Load Impedance, nominal	50 ohms
VSWR, Maximum, for full rated output	1.5:1
without damage	3:1
Efficiency,[2] Overall, Minimum	25%
Power Supply Requirements[3]	
Anode voltage	600 Volts
Current	125 mA
Heater voltage	6.0 Volts
Current	1.0 Amperes
Harmonic Suppression (2nd, 3rd and 4th of 2200-2300 Mc)	60 db
Warm-up Time	3 Minutes

MECHANICAL

Size, Overall (including protrusions)	3¾" x 2½" x 1½"
Weight	0.95 pounds
Mounting	To Heat Sink (not included)
Tuning Controls	Three (all on same surface)
Cooling	Conduction to Heat Sink at –54°C to +95°C
Connectors: rf input	OSM Female
rf output	OSM Female
Power	Deutsch #DM 5300-3P-643

ENVIRONMENTAL

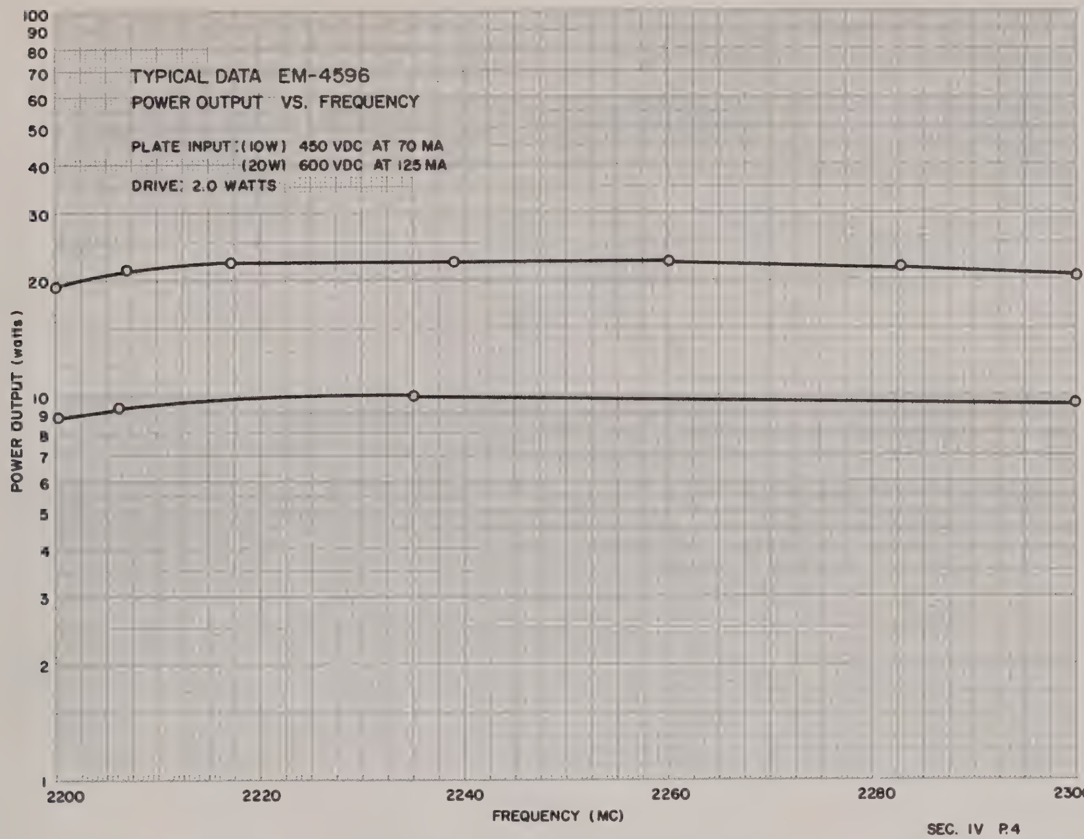
Temperature, heat sink, for continuous operation	–54°C to +95°C
Altitude	Any
Vibration	20g, 20-2000 cps, 3 major axes
Other	Per MIL-E-5400

FOOTNOTES:

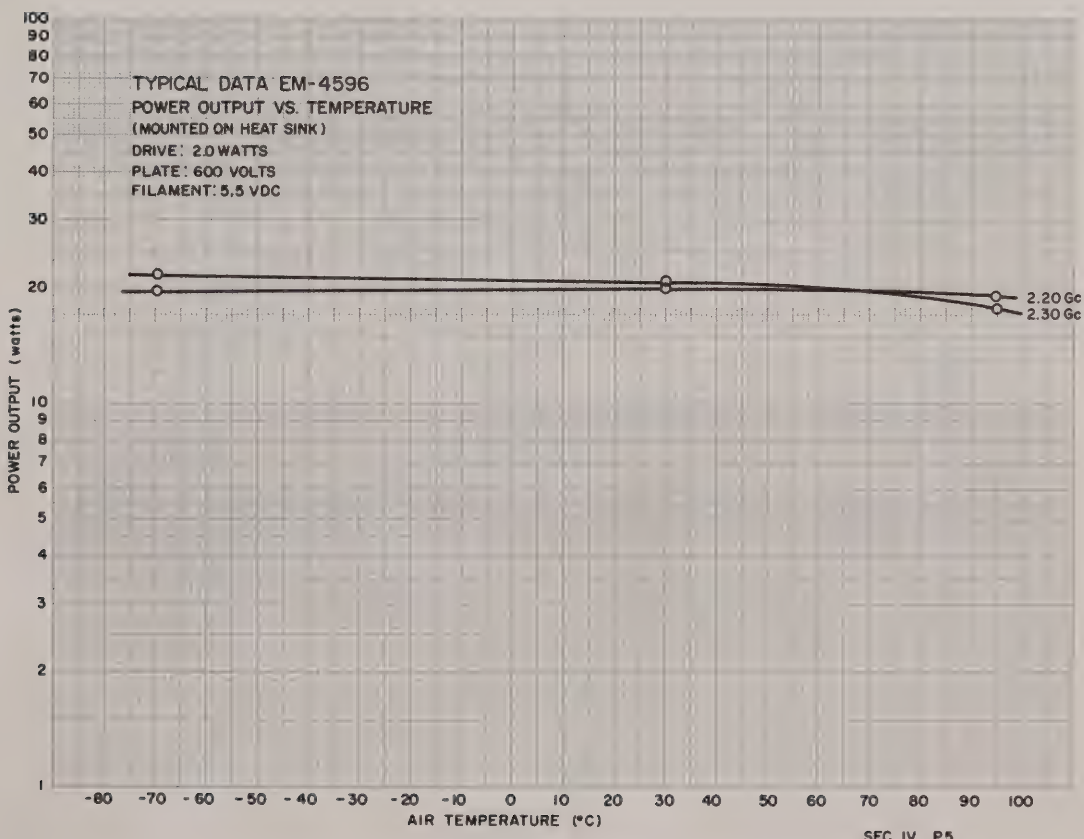
(1) Also available with similar performance characteristics for other frequencies in the 900-2500 Mc range. Model EM4539 covers 1420-1600 Mc, Model EM4592 covers 1700-1850 Mc.

(2) Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions. See curves for typical output and efficiency with other drive levels. Power output is 20 watts minimum, –54°C to +75°C.

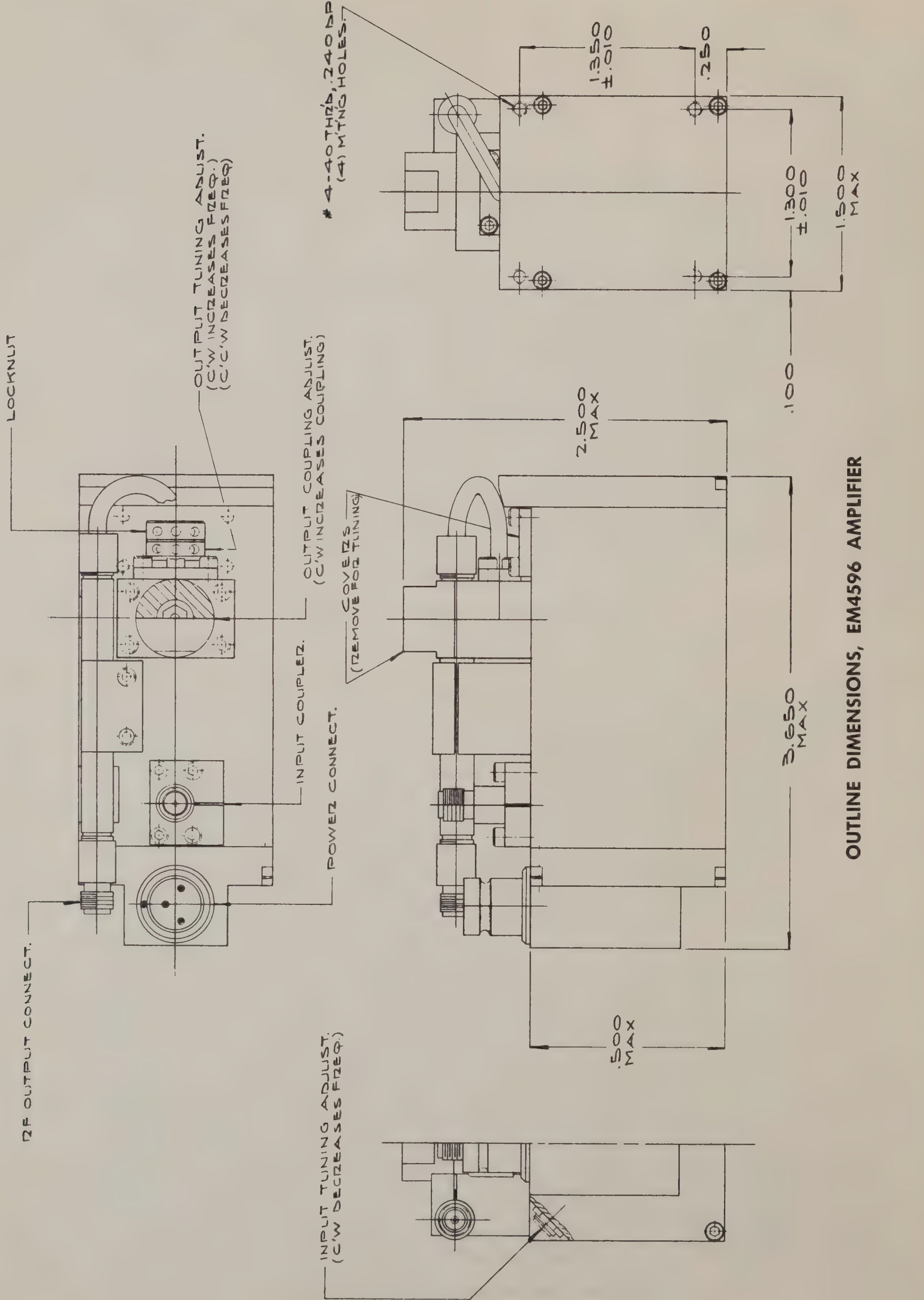
(3) A separate DC-DC converter package, Model EM4590, operating from 28 +8/–4 Vdc, is available from Eimac. Power supplies for operation from other primary sources are available on special order.



TUNING RANGE, EM4596 AMPLIFIER



TEMPERATURE EFFECT, EM4596 AMPLIFIER



OUTLINE DIMENSIONS, EM4596 AMPLIFIER

VOL. I

TO ALL EIMAC CATALOG HOLDERS

IMPORTANT TECHNICAL INFORMATION TO BE INSERTED
IN YOUR EIMAC HARD COVER CATALOG

Type of Information	New	Revision	Remove Sheet	Dated
General				
Table of Contents		7-31-65	Table of Contents	6-30-65
Tetrodes-Pentodes				
4CX350A/8321 & 4CX350F/8322		6-15-65	4CX350A/8321 & 4CX350F/8322	10-12-62
Other Products				
X6004 Ultraprobe	6-1-65			
Ceramic VacCap Vacuum Capacitors - Please Remove from Tube Manual				2-15-65

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TABLE OF CONTENTS
VOL. I

Effective Date 7-31-65

EITEL-McCULLOUGH, INC.

X6004 ULTRAPROBE

VACUUM LEAK DETECTOR PROBE

Eitel-McCullough, Inc., manufacturers of Eimac-brand electron power tubes for more than 30 years, now bring to the vacuum and aerospace industries a highly useful analytical tool for the precise location of vacuum leaks.

The Eimac Ultraprobe vacuum leak detector probe, used in conjunction with mass spectrometer leak detectors, can pinpoint leaks to within .010 of an inch in a fraction of the time required to locate leaks with conventional detectors.

PRINCIPLE OF OPERATION

The speed and accuracy of the Eimac Ultraprobe leak detector probe is made possible by a unique design based upon the principle of coaxial gas flow. Conventional probes, such as hypodermic needles, are limited in resolution due to the rapid diffusion of helium into the surrounding air as the gas is discharged from the tip of the probe. In the coaxial flow principle, the gas (He) is passed through the center of a diluting gas (N_2 or air). Upon discharged to the atmosphere, the diluting gas confines the concentrated detecting gas to a cone-shaped zone. With the Ultraprobe leak detector probe confining the detecting gas to a small area, it is quite simple to pinpoint leaks.

APPLICATION PROCEDURE

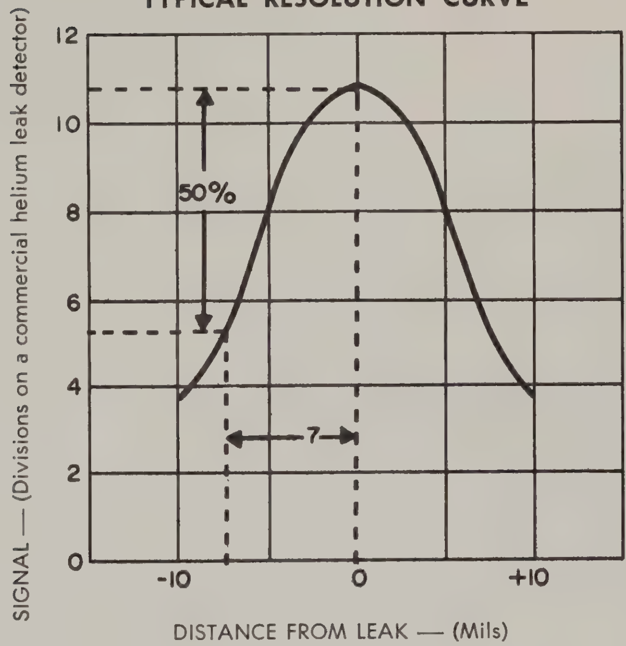
Four modes of operation have been incorporated into the Ultraprobe leak detector probe for convenience of operation. These modes precisely control gas flow to permit rapid detection of vacuun leaks as follows:

1. "DETECT" POSITION. In this mode, helium flows rapidly and unrestricted to blanket the work area and identify the general location of a leak.
2. "SEARCH" POSITION. The He flow is reduced and confined to a relatively small area by adding a flow of the diluting gas (N_2 or air.) This mode is comparable to the emission of a few bubbles of He per second from the tip of a hypodermic needle.
3. "LOCATE" POSITION. This mode further defines the leak area by further reducing the He flow while the diluting gas flow is held constant. Maximum resolution is achieved when the tip of the Ultraprobe leak detector probe is held approximately 1/64" away from the surface containg the leak.
4. "OFF" POSITION. The OFF mode provides a convenient means for placing the probe in standby operation. This allows minimum starting and shut-down time.

GAS REQUIREMENTS

Helium gas — 3to7 psig   Nitrogen or air — 3 to 7 psig — 2 scfh

TYPICAL RESOLUTION CURVE



PRICE $229.00

Contact—Director of Marketing
Eitel-McCullough, Inc.
301 Industrial Way
San Carlos, California 94071

—or your nearest
Eimac Field Sales Office

TABLE OF CONTENTS

VOL. II

* Divider Sheets Not Available

Effective Date 12-31-65

EIMAC

A Division of Varian Associates

5K70SG

S-BAND

24 KW CW

POWER AMPLIFIER KLYSTRON

The EIMAC 5K70SG power amplifier klystron was designed specifically for use in the ground transmitters of spacecraft communications systems. The outstanding characteristic of this klystron is its high efficiency of 55% at full power and bandwidth. The 5K70SG has a rated output power of 24 kilowatts at frequencies from 2090 to 2120 Mc with a 1 db bandwidth in excess of 15 Mc and a minimum gain of 50 db.

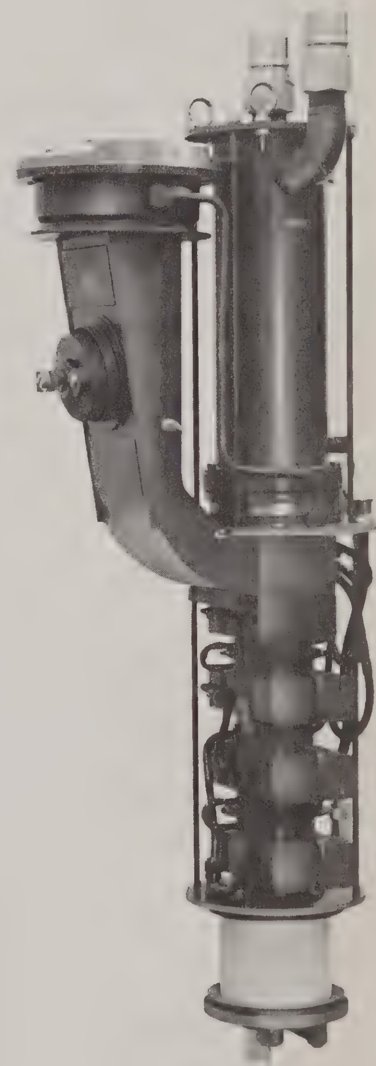
The specifications to which this klystron is manufactured require extraordinary performance as regards random amplitude modulated noise, long term stability, spurious outputs, long term group delay, and linearity. Performance details for the 5K70SG are listed elsewhere in this data sheet.

A large cathode is used in the 5K70SG providing cathode loading of less than 250 milliamperes per square centimeter. This light loading contributes to long life. The electron gun of this klystron provides an exceptionally uniform beam which contributes greatly to its stability and high efficiency.

Five integral cavities are used in the 5K70SG. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc which will withstand severe abuse. An arc detector is provided to protect this window.

The 5K70SG incorporates a built-in vacuum pump in the form of a titanium getter which should be energized whenever heater power is applied.

A focusing electromagnet, Catalog Number H-195, has been designed for use with the 5K70SG. EIMAC Water Load WL-204 is recommended for use with this klystron.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage (±5%)	7.5 Vac
Current (nominal)	11.5 Aac
Cathode: Oxide coated	
Heating Time	5 Min
Getter: Voltage	4 Vac
Current	24 Aac
Power Gain	50 db
Output Power	24 kW
Frequency Range	2090 to 2120 Mc
Random Amplitude Modulated Noise	—75 db
Stability (power variation over a 36 hour period)	±0.1 db
Spurious Output (excluding harmonics)	—85 db
Linearity (two tone test, 2 kW output power at each frequency)	—30 db
Phase shift as a function of beam voltage	0.0935 °/V

Printed in U.S.A.

MECHANICAL

Operating Position		any
Input Coupling (rf)		Type N Coaxial Fitting
Output Coupling (rf)		UG435A/U Flange
Weights: 5K70SG		100 lbs
H-195 Electromagnet		186 lbs
Tuner Starting Torque		80 in-oz
Tuner Stop Torque		30 in-lbs

Cooling: Forced Air and Solution of Water and Ethylene Glycol

	Flow Rate	*Pressure Drop*
Cathode	20 cfm	Free
Klystron Body	1.2 gpm	65 psi
Klystron Collector	18 gpm	40 psi
Electromagnet	2 gpm	30 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage, adjustable to	150 Vdc
Current, adjustable to	25 Adc

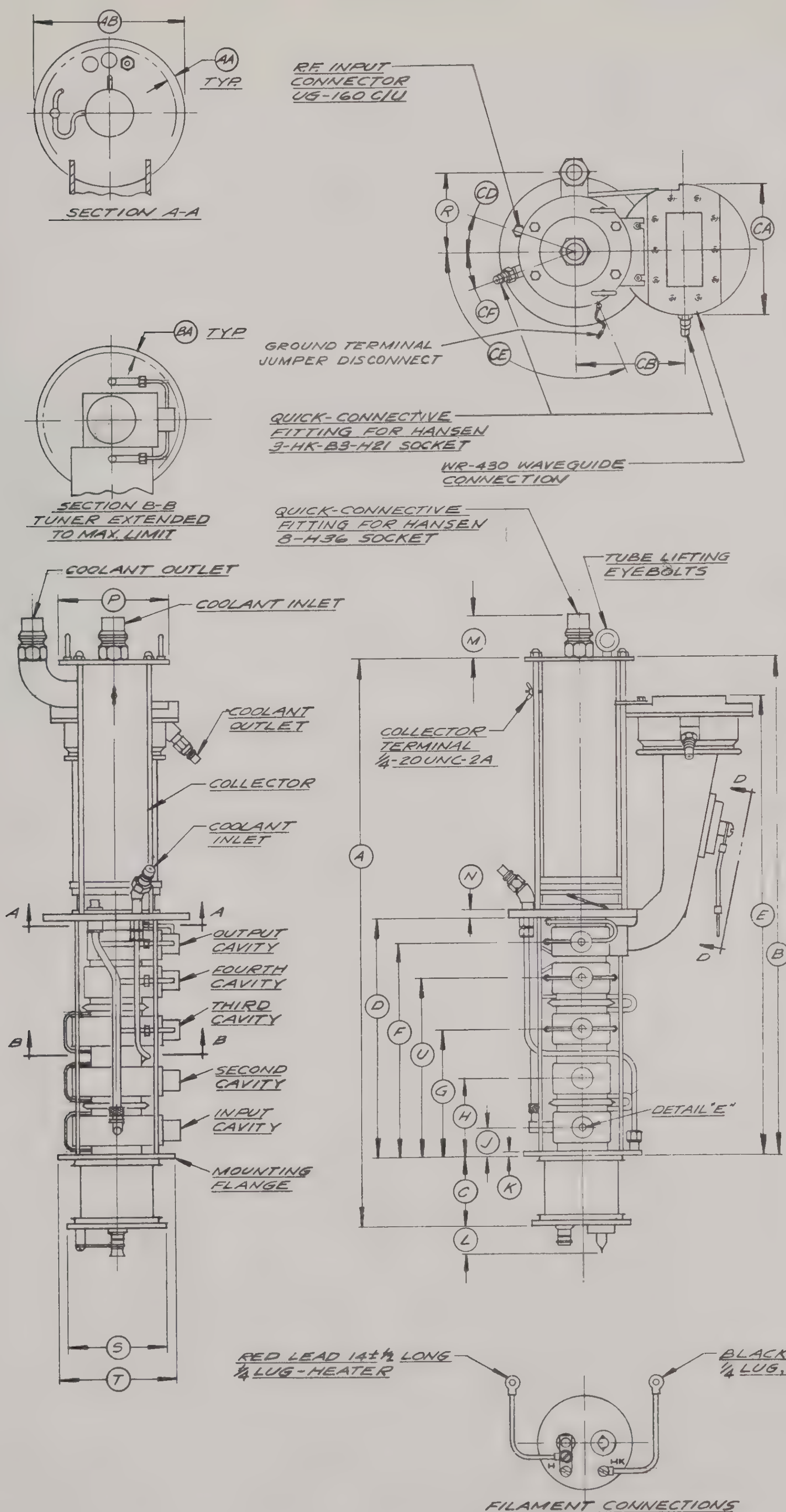
MAXIMUM RATINGS

BEAM VOLTAGE	23	kVdc
BEAM CURRENT	3	Adc
BEAM INPUT POWER	70	kW
BODY CURRENT	100	mAdc
COLLECTOR DISSIPATION	70	kW
INLET COOLANT PRESSURE	125	psig
COOLANT OUTLET TEMPERATURE	80	°C
LOAD VSWR	1.5:1	

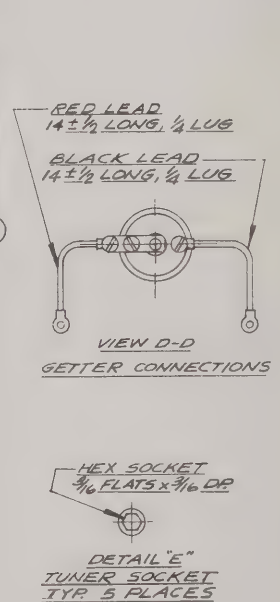
TYPICAL OPERATION — TUNED FOR BANDWIDTH

Frequency	2100	2100	Mc
Output Power	27	12	kW
Driving Power	150	160	mW
Power Gain	52.2	48.8	db
Beam Voltage	20	16	kVdc
Beam Current	2.425	1.575	Adc
Body Current	30	15	mAdc
1 db Bandwidth	17	14	Mc
Efficiency	55.7	50	%
Electromagnet Current	19	12.5	Adc

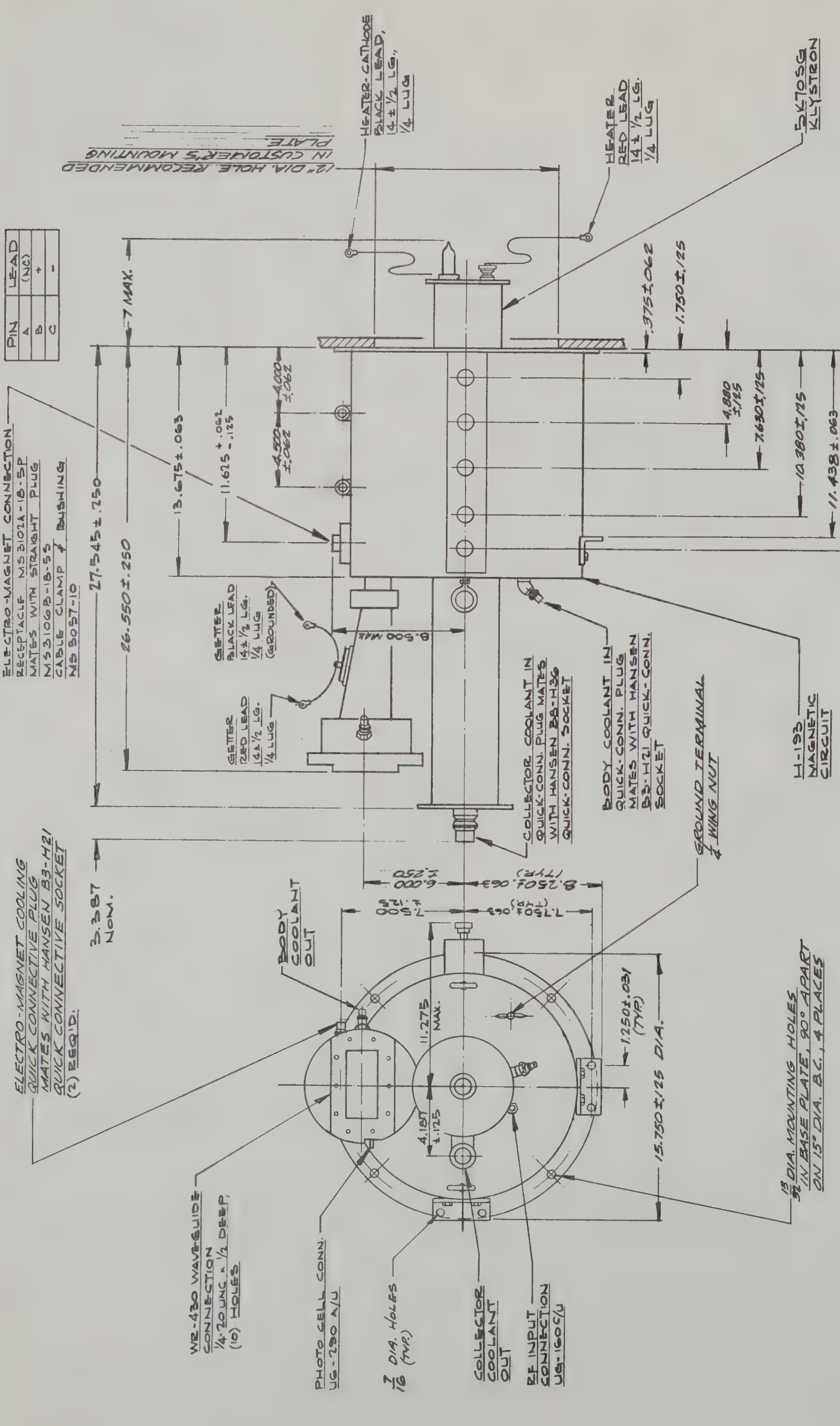
For additional information or information regarding a specific application, write to EIMAC a division of Varian, 301 Industrial Way, San Carlos, California



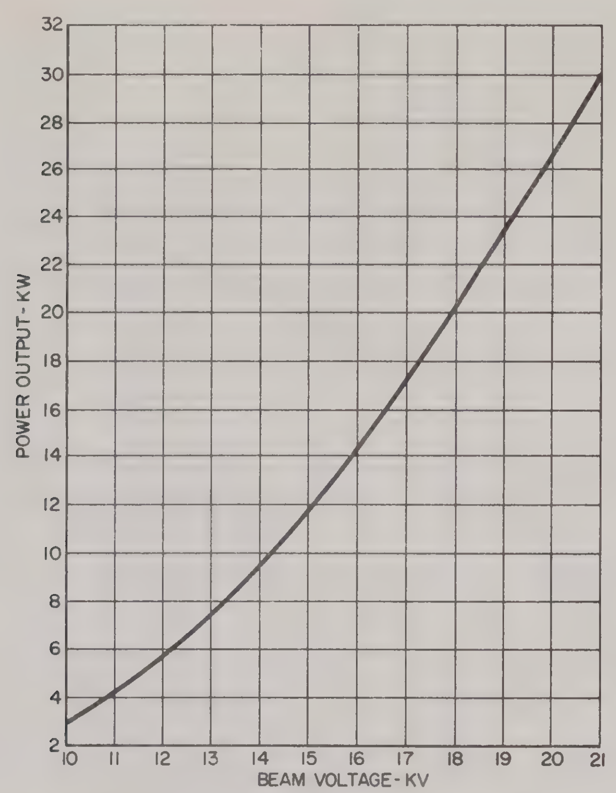
DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A		31.297	31.897
B		27.202	27.638
C		4.077	4.277
D		13.080	13.270
E		26.207	26.643
F		11.750	12.000
G		7.380	7.630
H		4.630	4.880
J		1.500	1.750
K		.230	.270
L			2.900
M		3.137	3.637
N		.345	.405
P		5.950	6.050
R		4.062	4.312
S			5.280
T		6.490	6.500
U		10.130	10.380
AA		.437	
AB		7.990	8.000
BA		.380	
CA		6.970	7.030
CB		5.750	6.250
CD		15°	25°
CE		110°	120°
CF		15°	25°



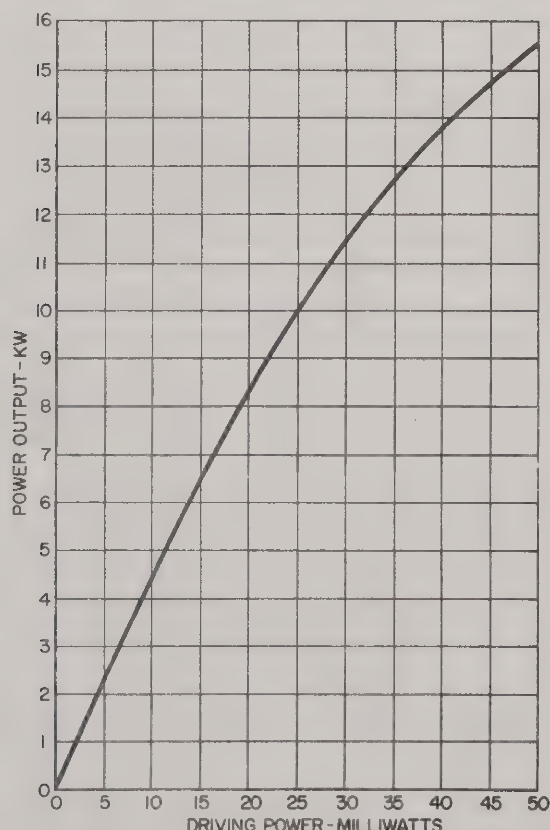
5K70SG KLYSTRON



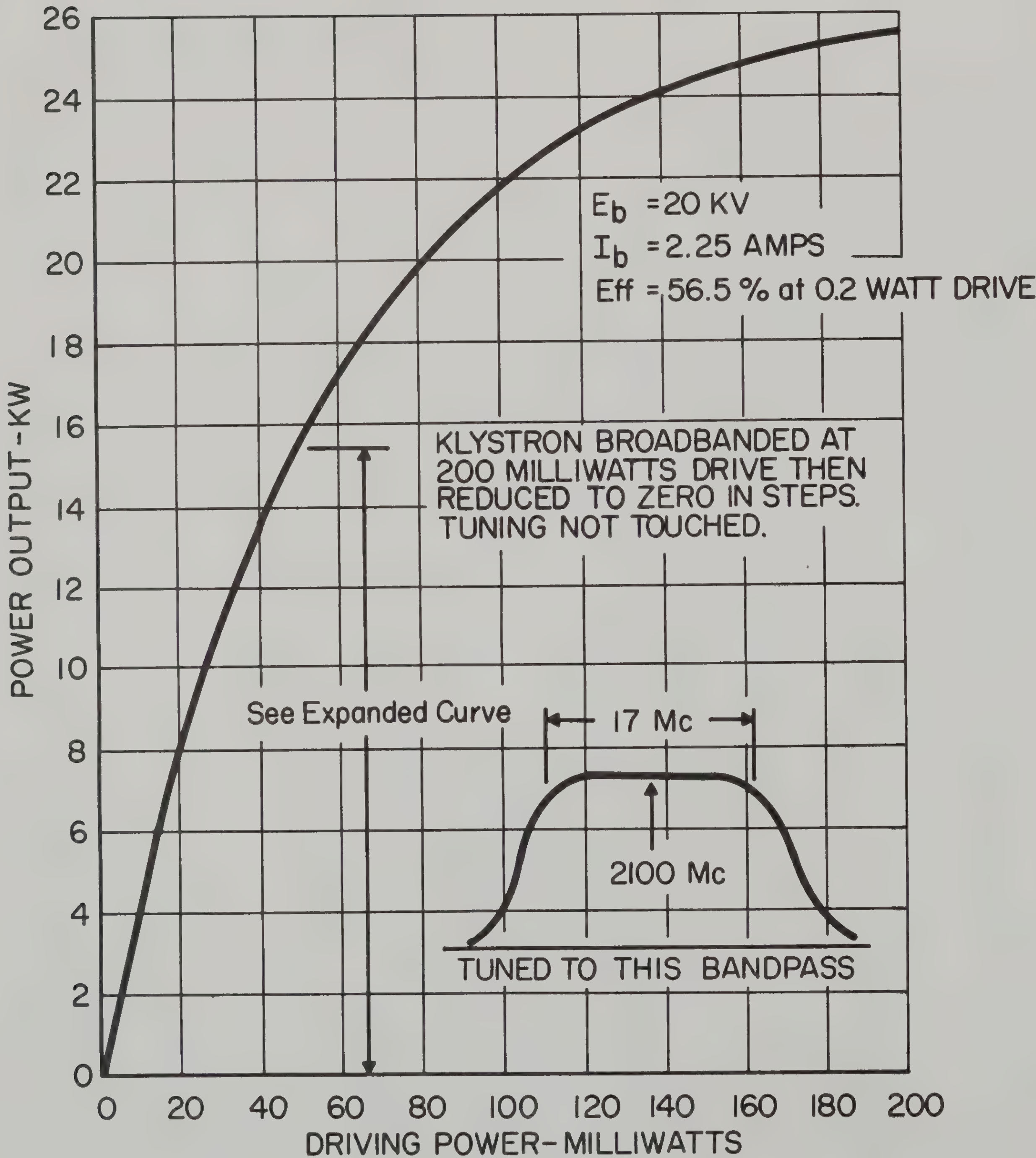
5K70SG KLYSTRON AND H-193 ELECTROMAGNET



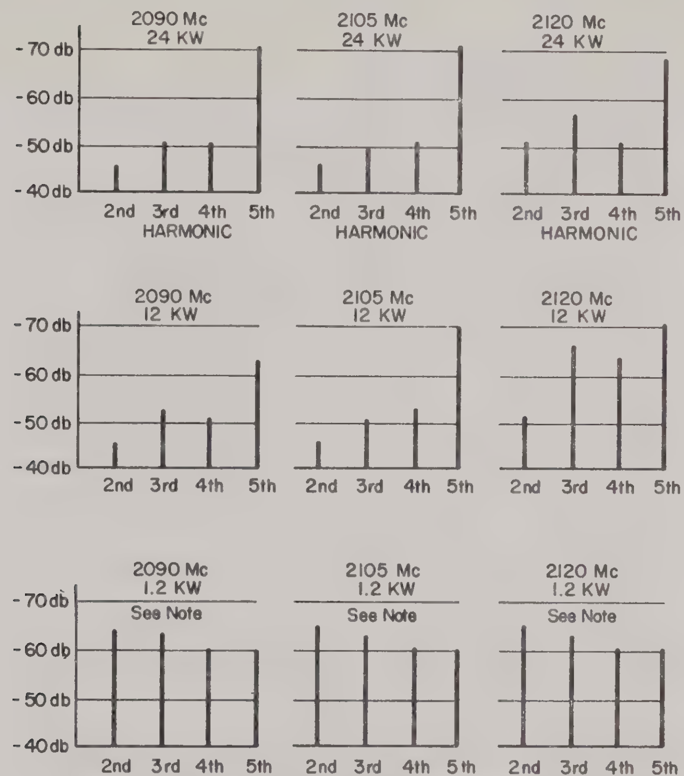
POWER OUTPUT vs. BEAM VOLTAGE (5K70SG)



EXPANDED LINEARITY CURVE

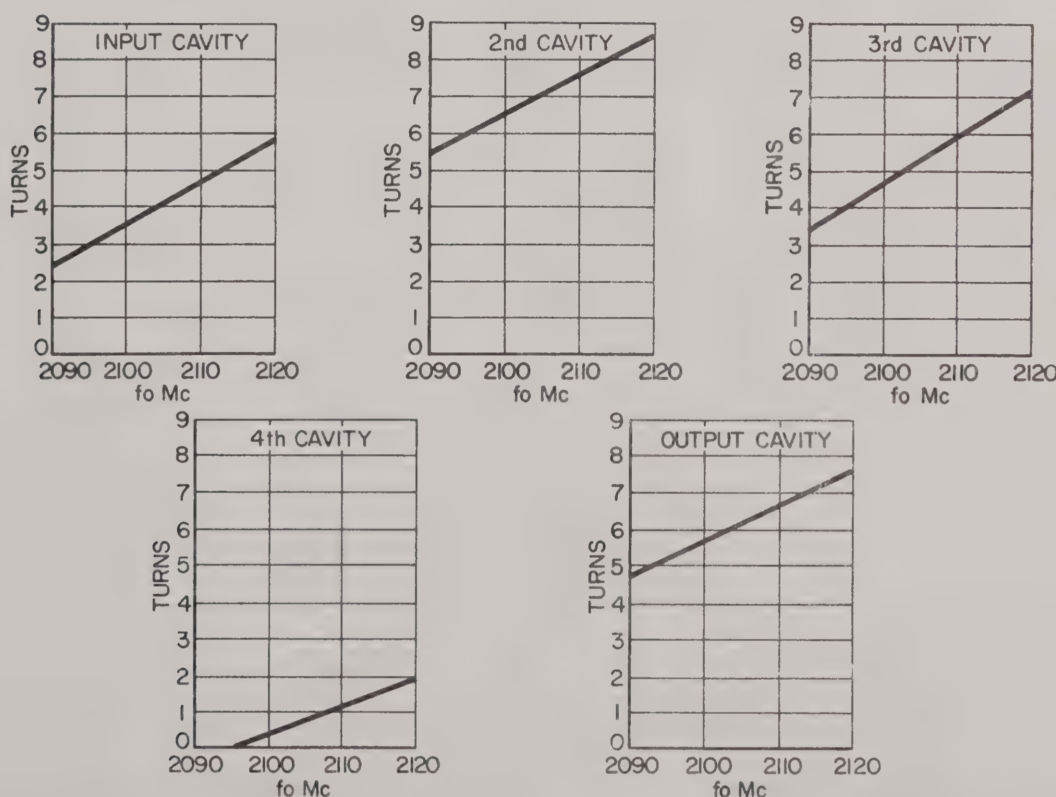


LINEARITY CURVE: POWER OUTPUT vs. DRIVE POWER (5K70SG)

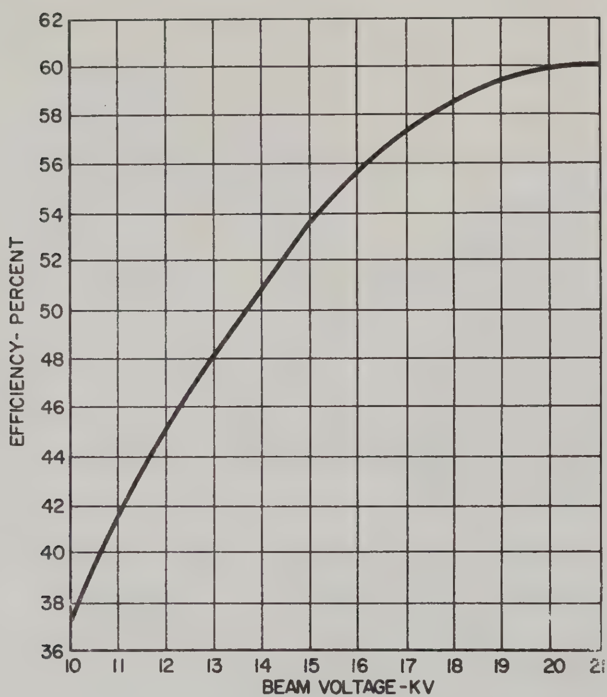


Note: VALUES SHOWN ARE LIMITS OF MEASUREMENT RESOLUTION AT THE 1.2 KW LEVEL.

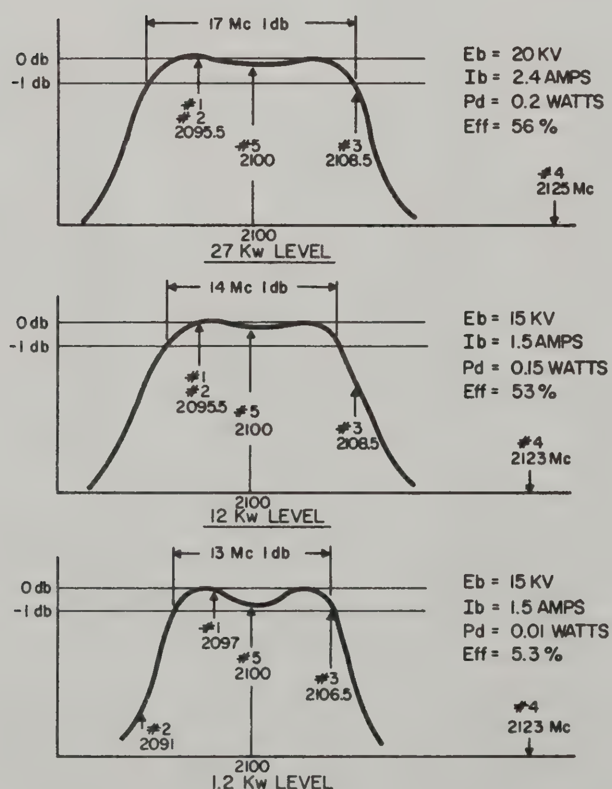
HARMONIC PATTERNS — 3 FREQUENCIES — 3 POWER LEVELS



CAVITY TUNING CURVES



EFFICIENCY vs. BEAM VOLTAGE (5K70SG)
TUNED FOR HIGH EFFICIENCY

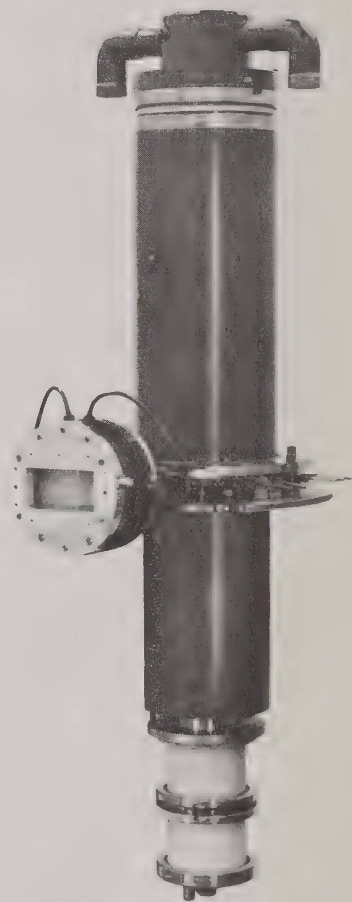


BANDPASS CHARACTERISTICS AND CAVITY PLACEMENT
FOR BROADBANDING AT THREE POWER LEVELS

Eimac®

EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

Tentative Data
5KM300SI
S-BAND
100 KW CW
POWER AMPLIFIER KLYSTRON



The Eimac 5KM300SI power amplifier klystron was designed specifically for use in the ground transmitters of spacecraft communications systems. The 5KM300SI has a rated output power of 100 kilowatts at frequencies from 2100 to 2400 megacycles with a 3 db bandwidth of 15 megacycles and a minimum gain of 55 decibels.

Five integral cavities are used in the 5KM300SI. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc which will withstand severe abuse. An arc detector is provided to protect this window.

The electron gun of this klystron provides an exceptionally uniform beam which contributes greatly to stability and high efficiency. This gun incorporates the Eimac Modulating Anode which provides a versatile means for controlling the beam.

The 5KM300SI incorporates an ion pump which maintains a low gas pressure in the klystron and also provides a continuous indication of this pressure during operation.

A focusing electromagnet, Catalog Number H-225, has been designed for use with the 5KM300SI.

CHARACTERISTICS

ELECTRICAL

Heater: Voltage (±5%)	13 Vac
Current (Nominal)	5.4 Aac
Cathode: Impregnated, Unipotential	
Heating Time	5 Min
Ion Pump Supply	
Voltage	3 to 4 kVdc
Current	1 mAdc
Power Gain	55 db
Output Power	100 kW
Frequency Range	2100 to 2400 Mc
Phase shift as a function of beam voltage	0.026 °/V

MECHANICAL

Operating Position	any
Input Coupling (rf)	UG-23 D/U
Output Coupling (rf)	WR-430 Waveguide
Weights: 5KM300SI	235 lbs
H-225 Electromagnet	180 lbs
Tuner Starting Torque (max)	50 in-oz
Tuner Stop Torque	6 in-lbs

Cooling: Forced Air and Water	*Flow Rate*	*Pressure Drop*
Cathode	25 cfm	Free
Klystron Body	2.3 gpm	60 psi
Klystron Collector	65 gpm	23 psi
Electromagnet	2.5 gpm	45 psi

Printed in U.S.A.

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

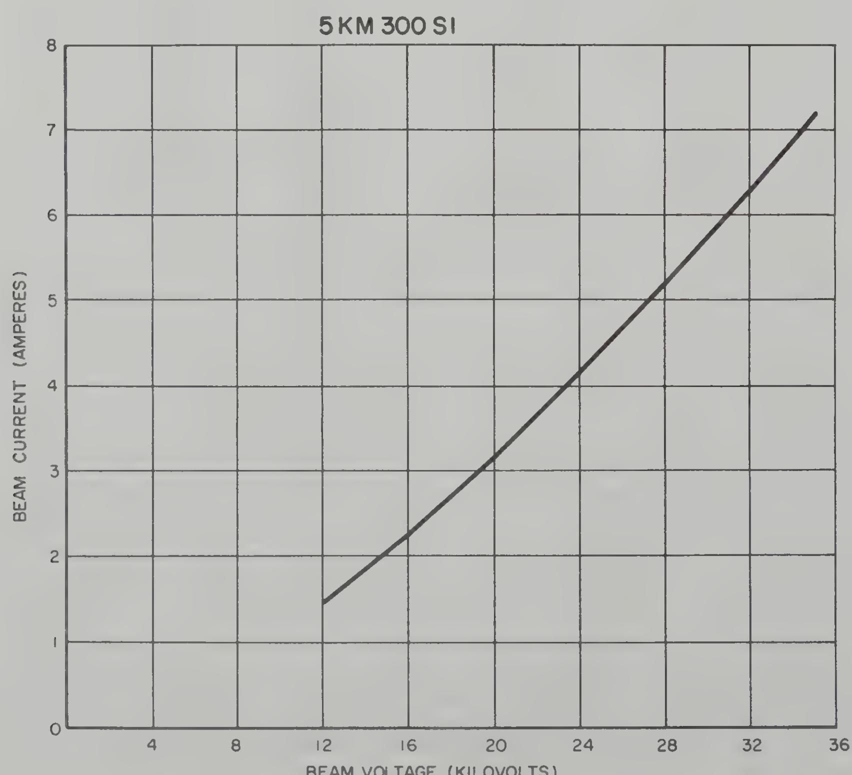
Voltage, adjustable to	160 Vdc
Current, adjustable to	20 Adc

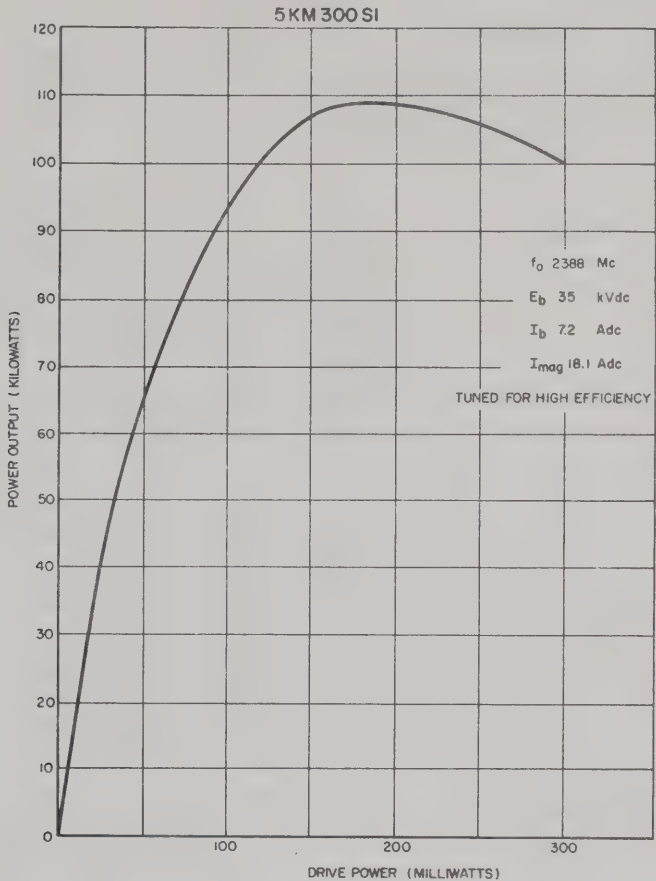
MAXIMUM RATINGS

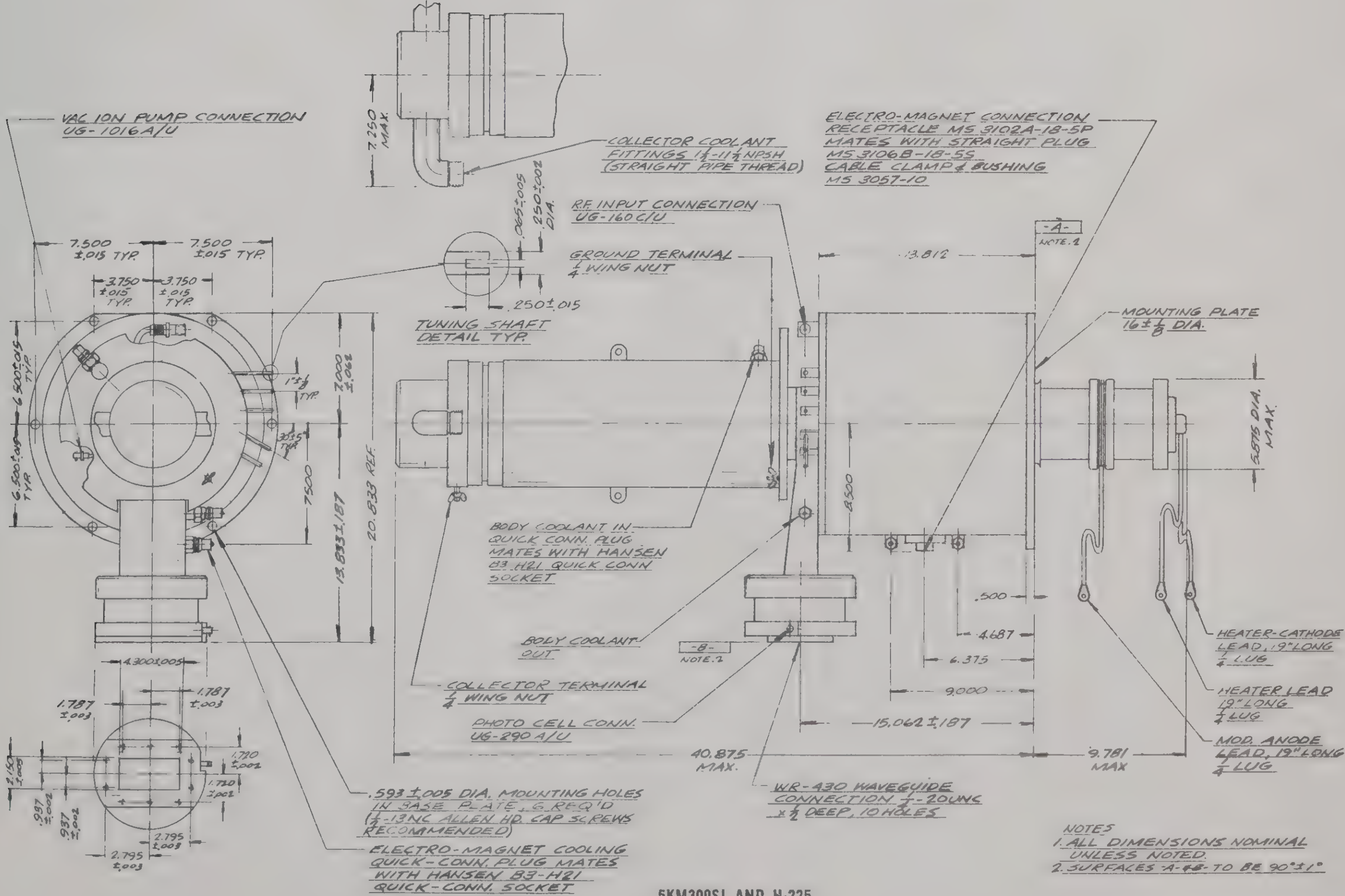
BEAM VOLTAGE	38 kVdc
BEAM CURRENT	7.9 Adc
BEAM INPUT POWER	300 kW
BODY CURRENT (WITHOUT DRIVE)	50 mAdc
BODY CURRENT (WITH DRIVE)	350 mAdc
COLLECTOR DISSIPATION	300 kW
INLET COOLANT PRESSURE	125 psig
COOLANT OUTLET TEMPERATURE	80 °C
LOAD VSWR	1.2:1

TYPICAL OPERATION

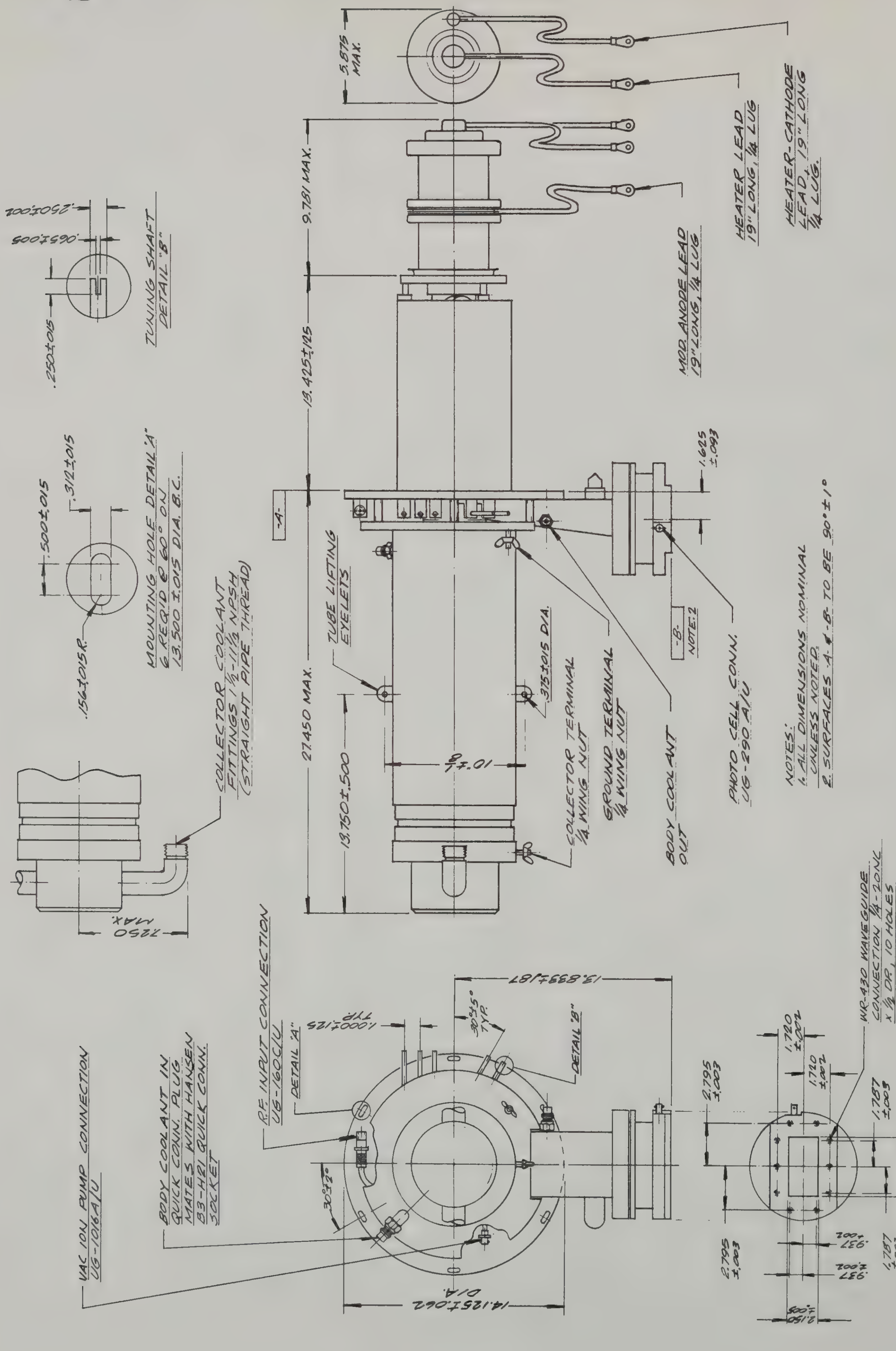
	Synchronously Tuned		*High Efficiency Tuned*		
Frequency	2115	2388	2115	2388	Mc
Output Power	74	79	104	109	kW
Driving Power	1	1.15	215	190	mW
Power Gain	78	78	57	57.3	db
Beam Voltage	35	35	35	35	kVdc
Beam Current	7.2	7.2	7.2	7.2	Adc
Body Current	135	85	340	190	mAdc
Modulating Anode Voltage (with respect to cathode)	35	35	35	35	kVdc
3 db Bandwidth	3.5	4	15	15	Mc
Efficiency	29.4	31.5	41.3	45.3	%
Electromagnet Current	18.1	18.1	18.1	18.1	Adc
Load VSWR	1.1:1	1.1:1	1.1:1	1.1:1	







5KM300SI AND H-225



5KM 300 SI KLYSTRON

EIMAC

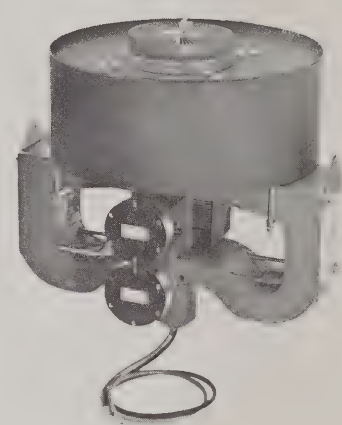
A Division of Varian Associates

Tentative Data

X3054

2.5 KW
POWER AMPLIFIER
C-BAND KLYSTRON

The Eimac X3054 is a five-cavity, air-cooled power amplifier klystron tunable over the frequency range of 5.925 to 6.425 gigacycles. It will deliver a minimum CW output power of 2.5 kilowatts with a minimum power gain of 50 decibels and a minimum 1 db bandwidth of 20 megacycles.



The very high gain and efficiency of this klystron make it particularly attractive for transportable equipment.

A common air inlet is used for collector and body cooling. Improved collector cooling is achieved through use of an integral plenum chamber which encloses the collector.

This klystron is focused with a permanent magnet and an auxiliary low voltage collector coil.

Both input and output rf couplings of the X3054 are fixed. The only adjustments required are the tuning of the cavities.

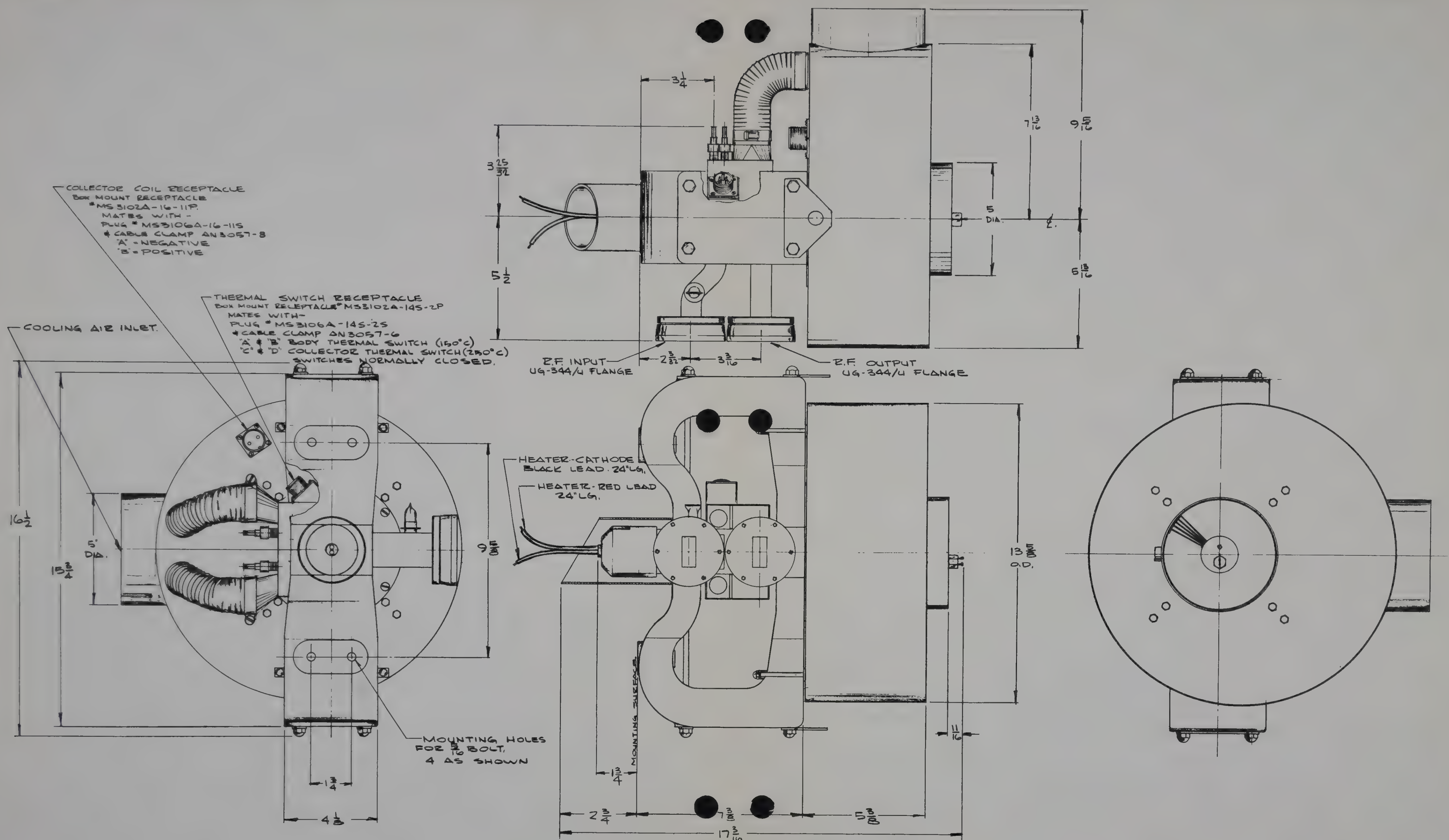
CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential		
Heating Time	5	minutes
Heater:		
Voltage (±5%)	5.75	volts
Current (nominal)	3.7	amperes
Power Gain	50	decibels
Output Power	2.5	kilowatts
Frequency Range	5.925-6.425	gigacycles

Printed in U.S.A.

X3054



X3054 KLYSTRON

MECHANICAL

Maximum Dimensions		
Length	17½	inches
Width	16½	inches
Depth	15½	inches
Weight	120	pounds
Input Coupling (rf)	UG-344/U	flange
Output Coupling (rf)	UG-344/U	flange
Maximum Tuner Start Torque	30	in-oz
Maximum Tuner Stop Torque	100	in-oz
Mounting Position		any

Cooling: Forced Air (25°C at sea level)

	Flow Rate	*Pressure Drop*
Body and Collector	175 cfm	1.2 in. H_2O

Collector Coil Power Supply Requirements - - - - - - - - 40 volts at 9 amperes

MAXIMUM RATINGS

BEAM VOLTAGE (dc)	8.5	kilovolts
BEAM CURRENT (dc)	0.85	ampere
BEAM INPUT POWER	6.5	kilowatts
BODY CURRENT WITH RF DRIVE (dc)	70	milliamperes
COLLECTOR DISSIPATION	6.5	kilowatts
LOAD VSWR	1.5:1	
TEMPERATURE OF BODY AND TUNER FINS	150°C	
TEMPERATURE OF COLLECTOR	250°C	

TYPICAL OPERATION — TUNED FOR BROADBAND OPERATION

Frequency	6175	megacycles
Output Power	2.7	kilowatts
Driving Power	8	milliwatts
Gain	56	decibels
Beam Voltage	8.2	kilovolts dc
Beam Current	0.74	ampere dc
Beam Power Efficiency	44	percent
1 db Bandwidth	24	megacycles
Body Current	40	milliamperes dc
Collector Coil Current	7	amperes dc

For additional information or information regarding a specific application, write to Eimac, a Division of Varian Associates, 301 Industrial Way, San Carlos, California

EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

TABLE OF CONTENTS

VOLUME II

* Divider Sheets Not Available

Effective Date 4-15-66

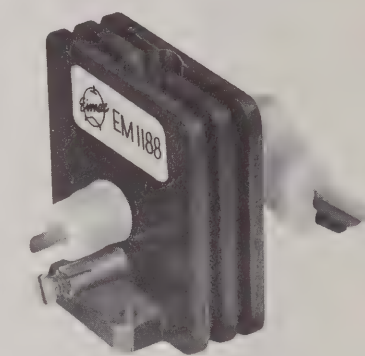
EIMAC

A Division of Varian Associates

EM1188

SERIES

K BAND REFLEX KLYSTRON



The Eimac EM1188 series of ruggedized ceramic/metal reflex klystrons operates in the 20 to 35 GHz region with long life and high reliability. EM1188 series tubes will deliver power outputs of 750 mW at a voltage of only 800 V over a 1000 MHz mechanical tuning range. External cavity tuning makes possible very stable operation.

The EM1188 was designed for application as a parametric amplifier pump source where excellent frequency and power stability are required. It also finds application in microwave equipments requiring a high frequency power source.

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

	*Operating Voltages** 650V	800V	
Frequency	20-35	20-35	(GHz)
Mechanically Tunable	0-1000	0-1000	(MHz)
Power Output	500	750	(mW)
Electronic Tuning Range (3 db bandwidth)	90	130	(MHz)
Resonator Voltage	650	800	(Vdc)
Cathode Current	60	70	(ma)
Repeller Voltage	—450	—450	(Vdc)
Repeller Modulation Sensitivity (3 db sweep)	2.0	2.0	(MHz/v)
Heater Voltage	6.3±5%	6.3±5%	(Vac)
Heater Current	0.7	0.7	(amps)
Temperature Coefficient	±250	±250	(KHz/°C)
Warm-up Time	45	45	(sec)

MAXIMUM RATINGS

Resonator Voltage	850	(Vdc)
Cathode Current	80	(ma)
Repeller Voltage (Negative with respect to cathode)	—50 to —700	(Vdc)

Note: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Electrical Connections (Type)	Flying leads
RF Output Coupling:	
(a) Flange size	UG595/u or UG599/u
(b) Waveguide size	RG53/u or RG96/u
Cooling Required	Conduction and/or forced air cooling*
Net Weight	Approx. 4 oz.

ENVIRONMENTAL PERFORMANCE

Temperature Range	Maintain flange temp. under 100°C
Altitude	100,000 ft.
Vibration	10 G, 10-1000 CPS
Shock	100 G, 11 msec

*See Application Notes

APPLICATION NOTES

Operating Voltages

For maximum performance, the tube must be factory preset for the desired operational voltage.

Cooling

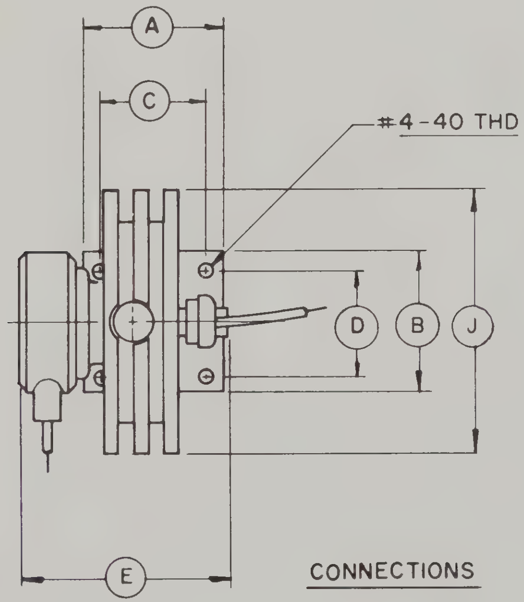
Conduction cooling thru waveguide flange and/or sufficient forced air cooling will be required to maintain the flange temperature of the tube below 100°C.

Resonator

The resonator of the EM1188 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode

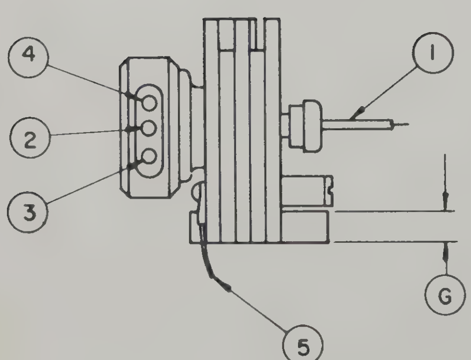
The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. The heater and cathode of the EM1188 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

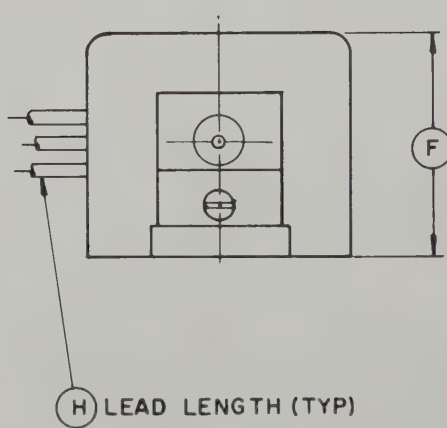


DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN	MAX	NOM
A	.865	.885	
B	.865	.885	
C	.665	.675	
D	.635	.645	
E		1.750	
F		1.750	
G	.180	.200	
H	11"		
J	1.65		

CONNECTIONS

1. REPELLER — GREY
2. HEATER — YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN





EIMAC

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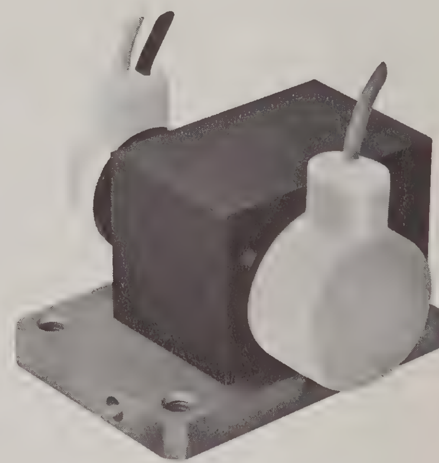
SAN CARLOS, CALIFORNIA

X-1095

REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency Setting	factory preset at frequency between 5.9 & 6.7 Gc
Power Output	400 mW
Electronic Tuning Range (3 db bandwidth)	100 Mc
Resonator Voltage	600 Vdc
Cathode Current	45 mA
Repeller Voltage	—100 to —200 Vdc
Modulation Sensitivity	2.0 to 3.0 Mc/V
Heater Voltage	6.3 V (ac or dc)
Heater Current	0.7 A
Mode	4¾
VSWR of Load	1.2:1 max
Temperature Coefficient	±50 kc/°C
Warm-up Time	30 seconds

MAXIMUM RATINGS

Resonator Voltage	700 Vdc
Cathode Current	60 mA
Repeller Voltage (negative with respect to the cathode)	—50 to —500 Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Electrical Connection	Flexible Leads
RF Output Coupling	See Outline Drawing
Cooling Required	Conduction
Net Weight	6 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature	—55°C to +125°C
Altitude	70,000 feet max
Vibration	10 G, 5 to 2000 cps
Shock	100 G, 11 ms

OUTLINE DIMENSIONS

Height	1.42 inches
Width	2.00 inches
Length	2.45 inches

APPLICATION NOTES

NOTE: All voltages referred to the cathode.

COOLING: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat-sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

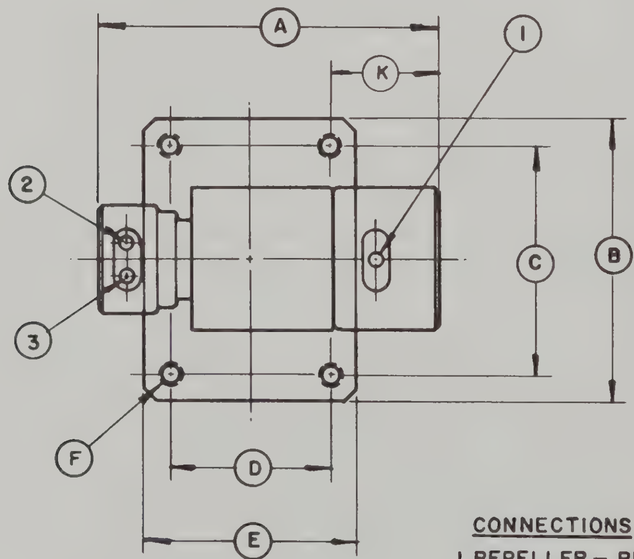
RESONATOR: The resonator of the X1095 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1095 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

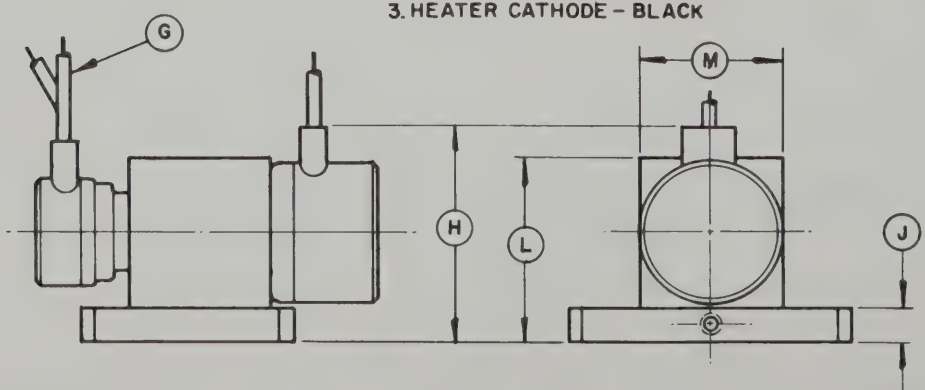
VSWR OF LOAD: To obtain the typical performance listed, the load VSWR should be less than 1.2:1.

DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		2.520	
B		2.015	
C	1.620	1.630	
D	1.120	1.130	
E		1.515	
F	#8-32 TAP		
G	12±1 TYP LEAD LENGTH		
H			1.500
J		.260	
K	.800	.880	
L		1.325	
M		1.015	



CONNECTIONS

1. REPELLER – RED
2. HEATER – WHITE
3. HEATER CATHODE – BLACK



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SAN CARLOS, CALIFORNIA

EM1300

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

250 - 500 Mc

100 mw

DESCRIPTION

The EM1300 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 250-500 mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.

FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Rugged
- Flat Power Output

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	250-500 Mc
Anode Voltage	920-1840 V
Cathode Current	0.5-2 mA
Typical Power Output	140 mw
Anode FM Sensitivity	0.3 Mc/V
Injection Anode Voltage	200 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.9 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.8 lbs.

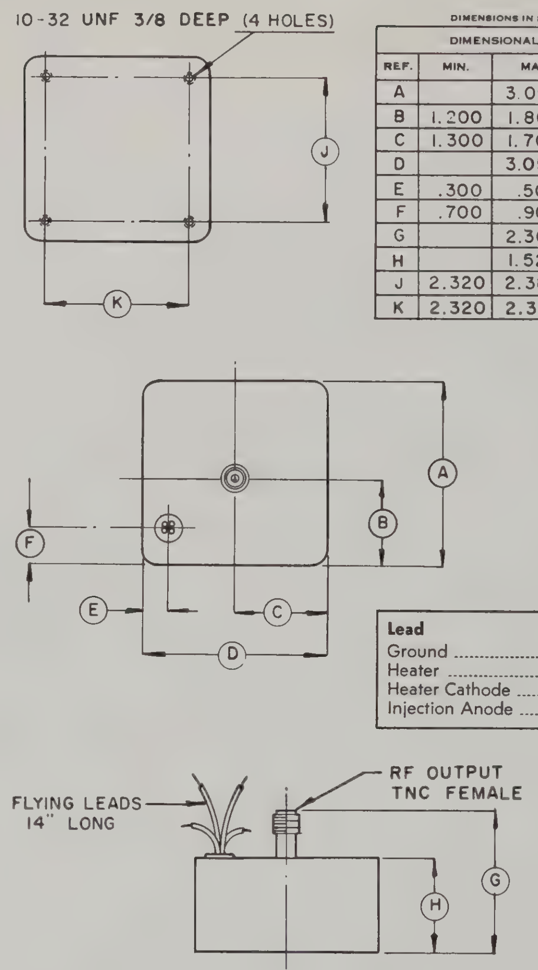
MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	10 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	0.5 mA
Load VSWR	3:1

*Damage to the tube may occur if maximum ratings are exceeded.

NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

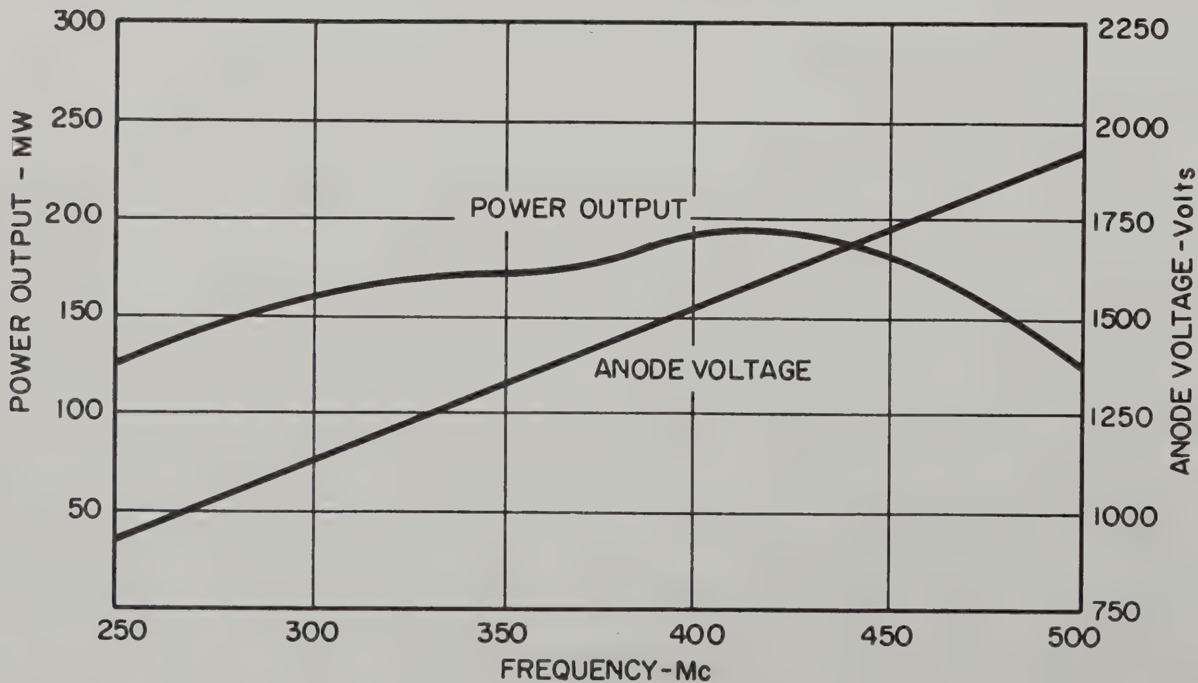


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	

Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White

CHARACTERISTIC CURVES
Typical Performance Values



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SAN CARLOS, CALIFORNIA

EM1310

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

500 -1000 Mc

100 mw

DESCRIPTION

The EM1310 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 500-1000 Mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.

FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Flat Power Output
- Rugged

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	500-1000 Mc
Anode Voltage	920-1840 V
Cathode Current	0.5-2 mA
Typical Power Output	150 mw
Anode FM Sensitivity	0.55 Mc/V
Injection Anode Voltage	150 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.86 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.5 lbs. max.

MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	10 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	1 mA
Load VSWR	3:1

*Damage to the tube may occur if maximum ratings are exceeded.

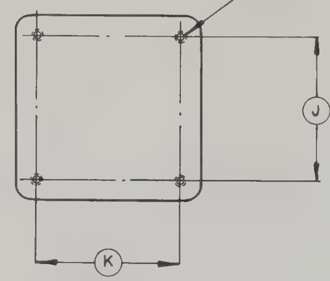
NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.

2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.

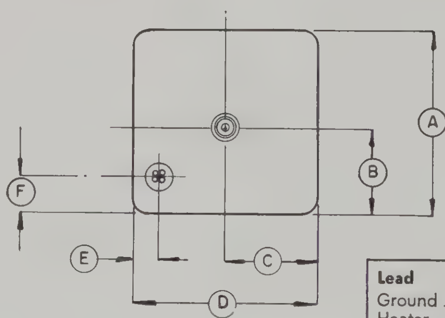
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.

4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

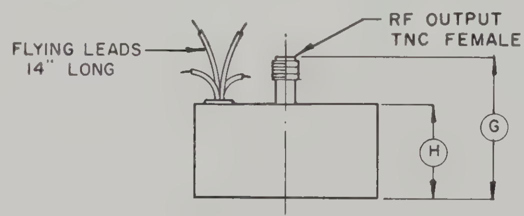


DIMENSIONS IN INCHES

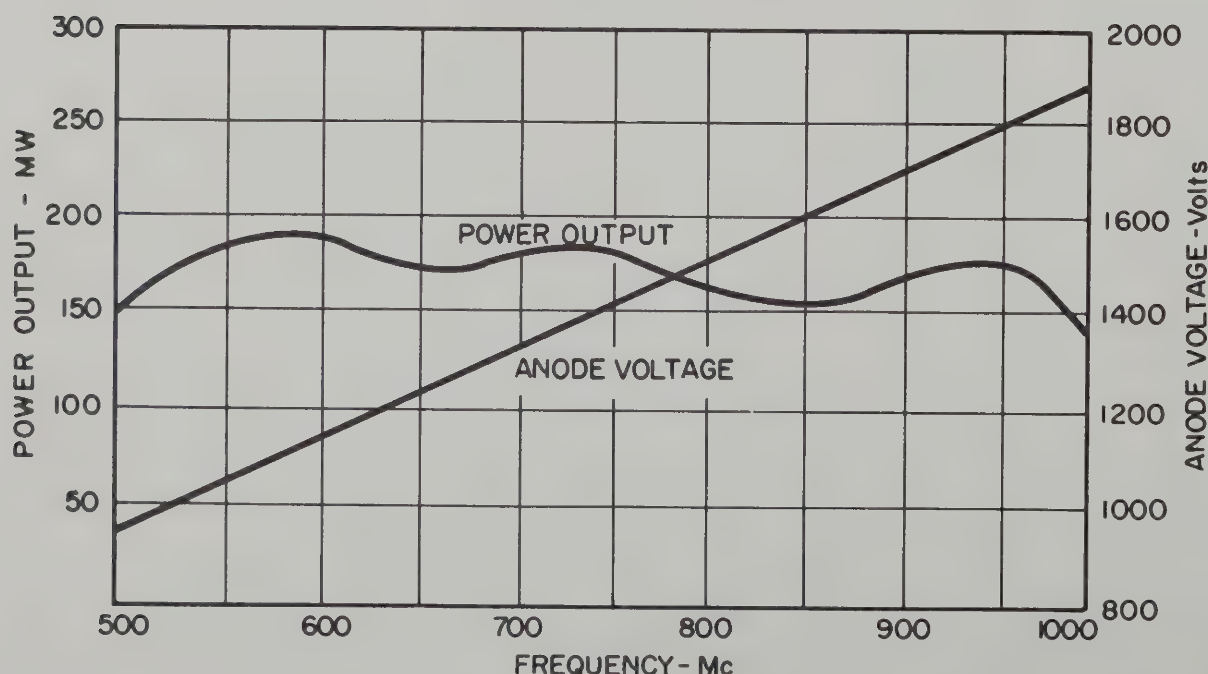
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	



Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White



CHARACTERISTIC CURVES
Typical Performance Values



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EM1320

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

1000 - 2000 Mc

100 mw

DESCRIPTION

The EM1320 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 1000-2000 mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.

FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Flat Power Output
- Rugged

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	1000-2000 Mc
Anode Voltage	920-1840 V
Cathode Current	1-6 mA
Typical Power Output	200 mw
Anode FM Sensitivity	1 Mc/Volt
Injection Anode Voltage	200 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.9 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.5 lbs.

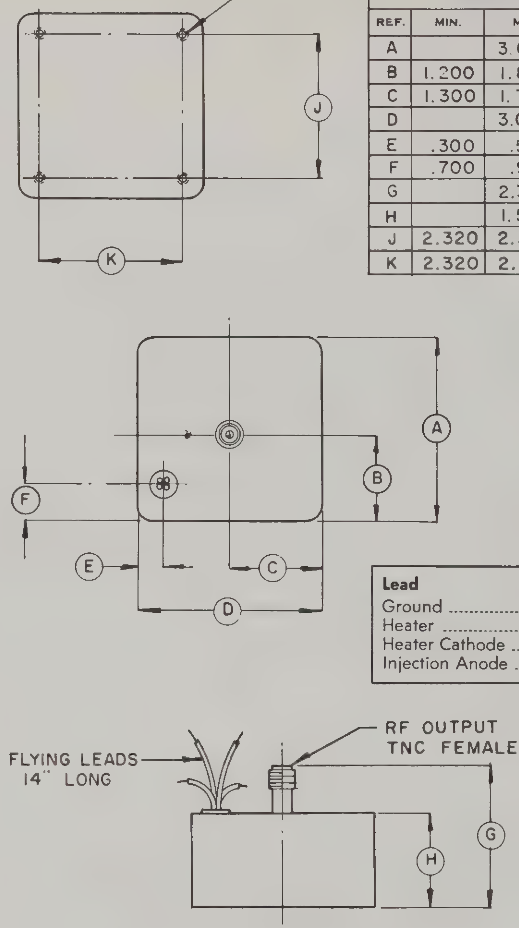
MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	12 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	1 mA
Load VSWR	3:1

*Damage to the tube may occur if maximum ratings are exceeded.

NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

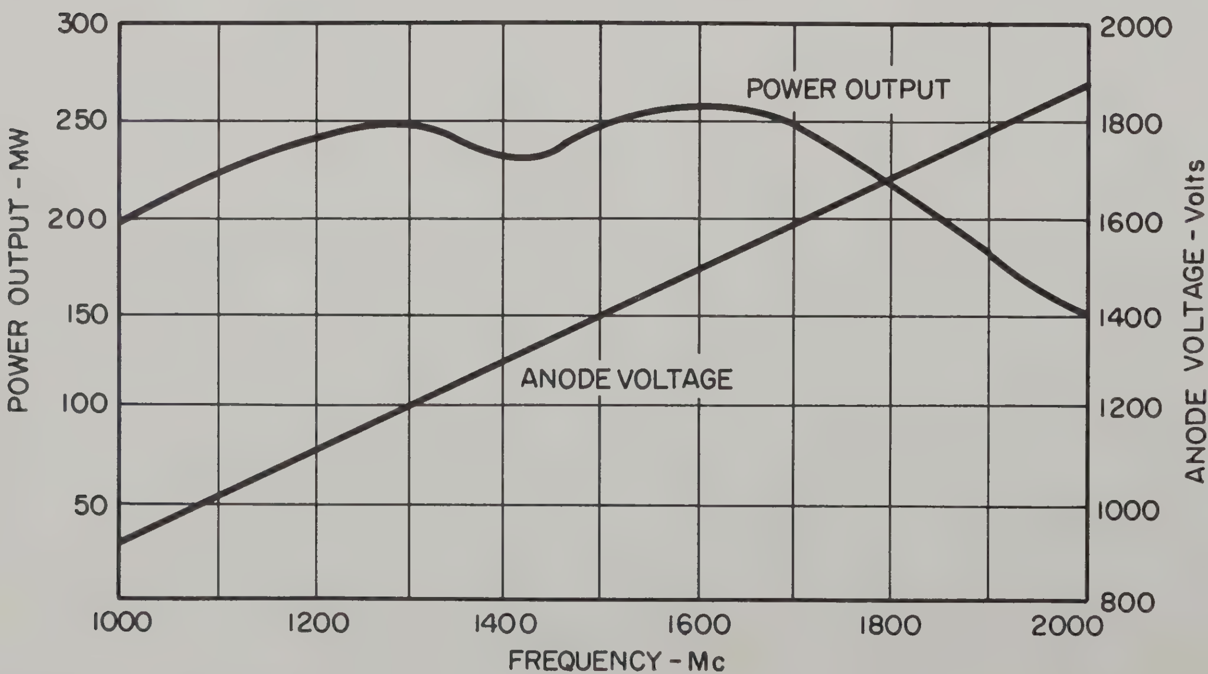


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	

Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White

CHARACTERISTIC CURVES
Typical Performance Values



EIMAC

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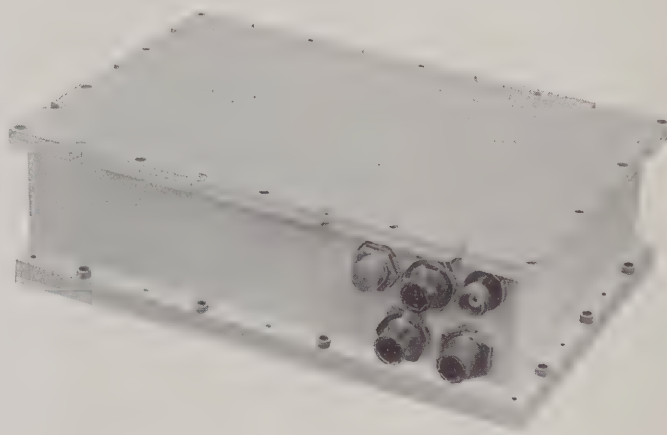
EM4567

TELEMETRY TRANSMITTER

2200 - 2300 MHz
10 Watts

This Eimac S-Band transmitter provides over 10 watts rf output with over 15% overall efficiency, under all combinations of worst specified environmental extremes and primary power variation. Frequency change, if desired, is easily accomplished in the field. It is designed to operate during the severe shock and vibration of missile launch.



Model EM4567 is a complete transmitter, including a pre-regulated DC-DC converter. All circuits are solid state, except the rf power oscillator, which is a single stage rugged ceramic planar triode. RF is generated at the output frequency. The complete transmitter is packaged in less than 110 cubic inches, and weighs less than 8 pounds. Modulation is true FM. Major features of this transmitter include:

Easy Tuning: A simple crystal change will allow the output to be tuned to any frequency in the 2.2-2.3 GHz band. Test points are provided. A minimum of test equipment is required. Adjustment of temperature compensation is not required.

High Reliability: Since the rf power output is produced by a single stage, this transmitter has a minimum number of components, tuning adjustments and connections. All components are used well below maximum ratings, and circuits are epoxy encapsulated for environmental protection.

Wide Temperature Range: This transmitter will meet full performance specifications over the range –40°C to +85°C.

Modulation Bandwidth and Linearity: Deviation of ±1.5 MHz is accomplithed at ±2.5% linearity, and ±300KHz at ±0.5% linearity.

(Effective 1-15-66)

CHARACTERISTICS

ELECTRICAL

Frequency, Tunable	2200-2300 MHz
Power Output, CW Minimum[7]	10 Watts
Frequency Accuracy	±0.001%
Frequency Stability[8]	±0.0025%
Carrier Deviation, Adjustable, peak-to-peak	2MHz/Volt to 30KHz/Volt
Modulation Bandwidth,[1] Flat within ±0.5 db	100 Hz to 500 KHz
Flat within ±1 db	5 Hz to 800 KHz
Flat within ±2 db	5 Hz to 2 MHz
Modulation Linearity, Deviation from B.S.L.,	
For ±300 KHz peak Deviation	±0.5%
For ±1.5 MHz peak Deviation	±2.5%
Incidental Frequency Modulation, Maximum	5 KHz rms
AM, Maximum, due to environmental conditions	1%
due to ±300 KHz carrier deviation	1%
due to ±1.5 MHz carrier deviation	5%
Modulation Input Impedance, Minimum, 5 Hz to 800 KHz	10,000 Ohms
Primary Voltage required[2]	$28 \pm^{8}_{4}$ Vdc
Primary current required, maximum, at 28 Vdc	2.4A
Primary Ripple, maximum, peak-to-peak from Dc to 20 KHz	8 volts
Transients, Maximum positive	80 volts for 20 microseconds
Input current rise above nominal, due to fault,[3] maximum	30%
VSWR Maximum, any phase, for 10 watts output[7]	1.5:1
for 5 watt output	5.5:1
Load Impedance required	50 ohms
Warm-up time to meet all specifications	120 seconds
Interference	All applicable requirements of MIL-I-26600 and MIL-I-6181D are met
Life (95% probability, 60% confidence factor)	500 hours

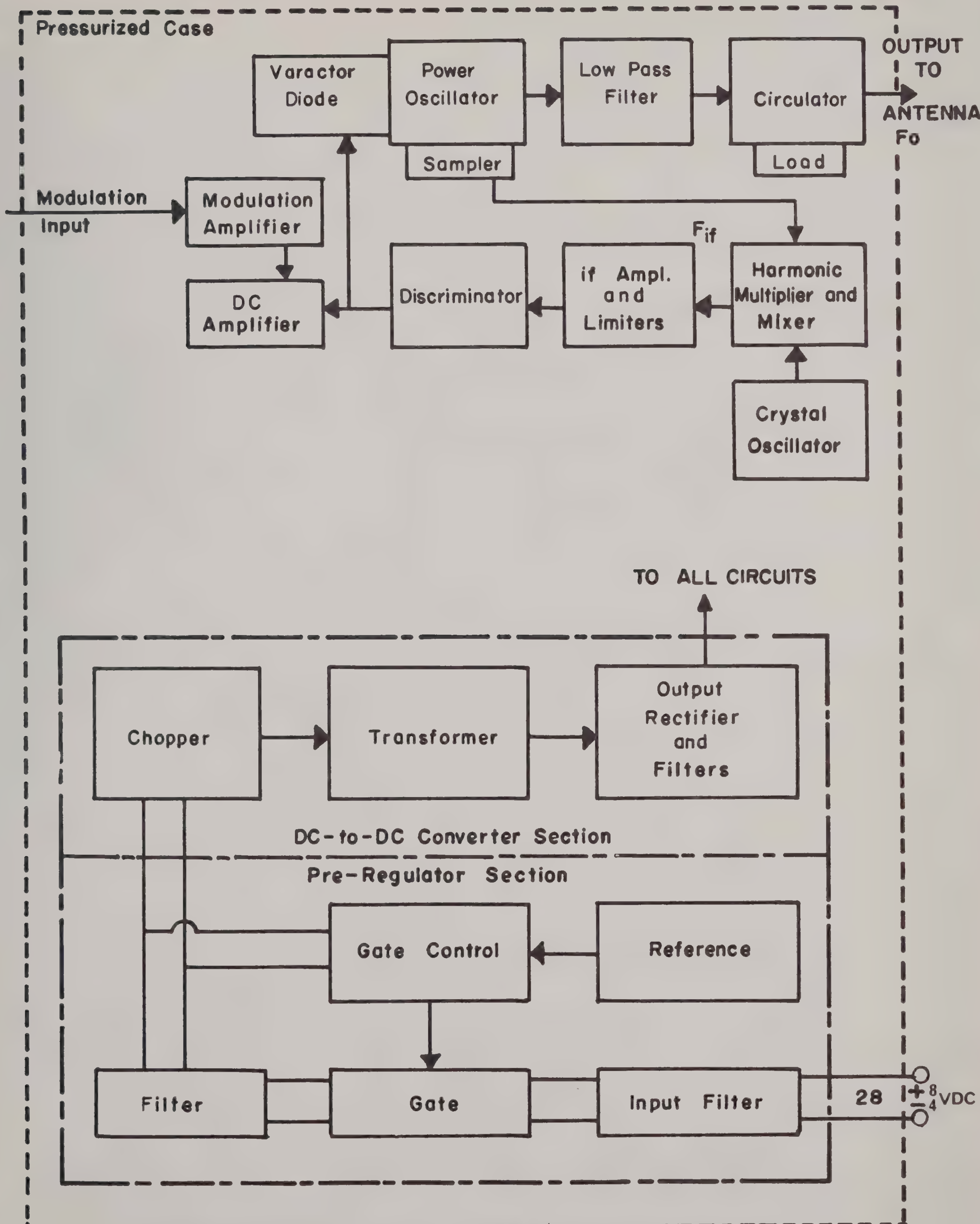
PACKAGING

Volume displaced	98 cubic inches
Dimensions, including mounting flanges	8.3″ x 5.5″ x 2.525″
Weight	8 pounds
Pressurization	30 psia
Cooling	Conduction to heat sink
Connectors, rf	TNC Female
Power and Modulation	Bendix PTO7 Male

ENVIRONMENTAL SPECIFICATIONS[4]

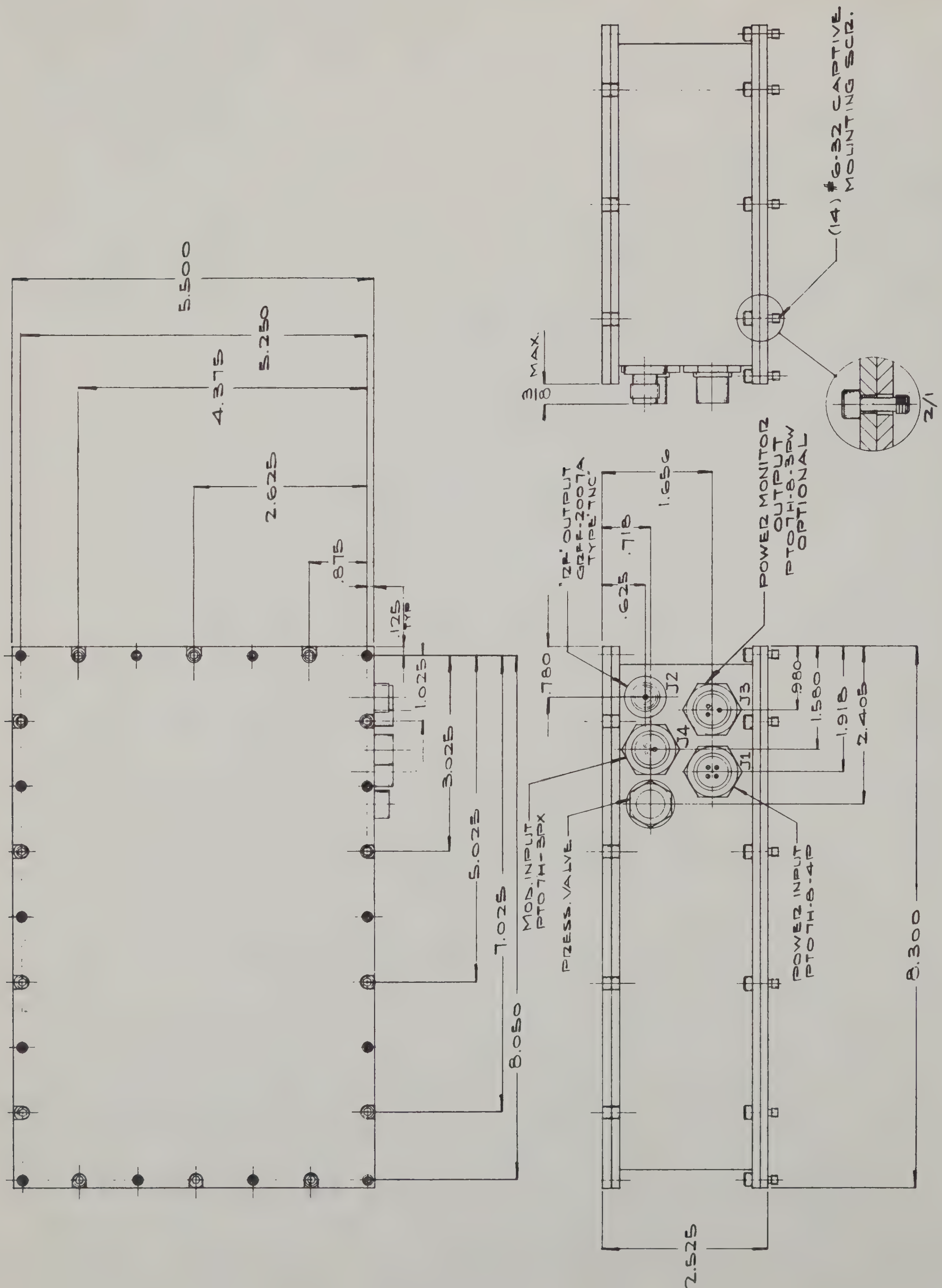
Temperature[5] at heat sink (Continuous Operation)	—40°C to +85°C
Altitude	Any
Vibration[9] (MIL-STD-810, Figure 514-3, Curve D)	15G peak to 2 KHz
(MIL-STD-810, Figure 514-4, Curve E)	0.2 G^2/Hz
Air Induced Vibration	150 db above $2 \times 10^{-4}/CM^2$ from 150 to 2000 Hz, 30 minutes
Explosive Atmosphere	Capable of operation without igniting an explosion
Sustained Acceleration	30G for 5 minutes, three axes
Shock[9], per MIL-STD-810 Method 516, Procedures I and V,	
half-sine shocks	15G for 11 milliseconds
sawtooth shocks[6]	100G

9Available for use in more severe environment, on special order.
8Stability of ±0.001% from —40°C to +85°C is available on special order.
7Over temperature range —20°C to +70°C. Minimum power output for —40°C to +85°C is 8 watts.
6Out-of-tolerance operation may occur during 100G shock.
5Other ranges available on special order.
4Transmitter performs as specified, under any combination of environmental conditions.
3Any failure of transmitter (except at input terminals).
2Under emergency conditions, full rf output is provided with primary power as low as 20 Vdc, but increased IFM and AM will occur.
1Also available modified for modulation down to DC.



BLOCK DIAGRAM

EM4567 10 Watts 2200 - 2300 MHz TELEMETRY TRANSMITTER


5.500
5.250
4.375
2.625
.875
.125 TYP
1.025
3.025
5.025
7.025
8.050
.780
.625
.718
1.656
'ZR' OUTPUT GRF-2007A TYPE 'TNC'
POWER MONITOR OUTPUT PT07H-8-3PW OPTIONAL
J1
J2
J3
J4
.980
1.580
1.918
2.405
MOD. INPUT PT07H-3PX
PRESS. VALVE
POWER INPUT PT07H-8-4P
8.300
2.525
3/8 MAX.
(14) #6-32 CAPTIVE MOUNTING SCR.
2/1

EIMAC

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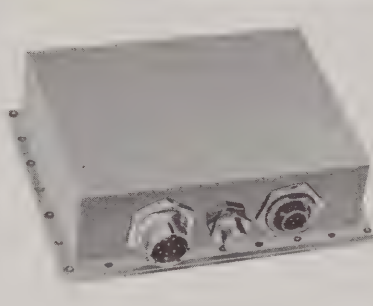
EM4590

POWER SUPPLY

The EIMAC Model EM4590 is a solid state dc-dc converter, recommended for use with 10-30 watt output rf cavity amplifiers and oscillators. It provides regulated plate and heater voltages, operating from 28 Vdc primary source. This is a compact, light weight, high efficiency, conduction-cooled unit. It operates satisfactorily during the shock and vibration of missile launch. It is hermetically sealed, for operation at any altitude.



CHARACTERISTICS

ELECTRICAL

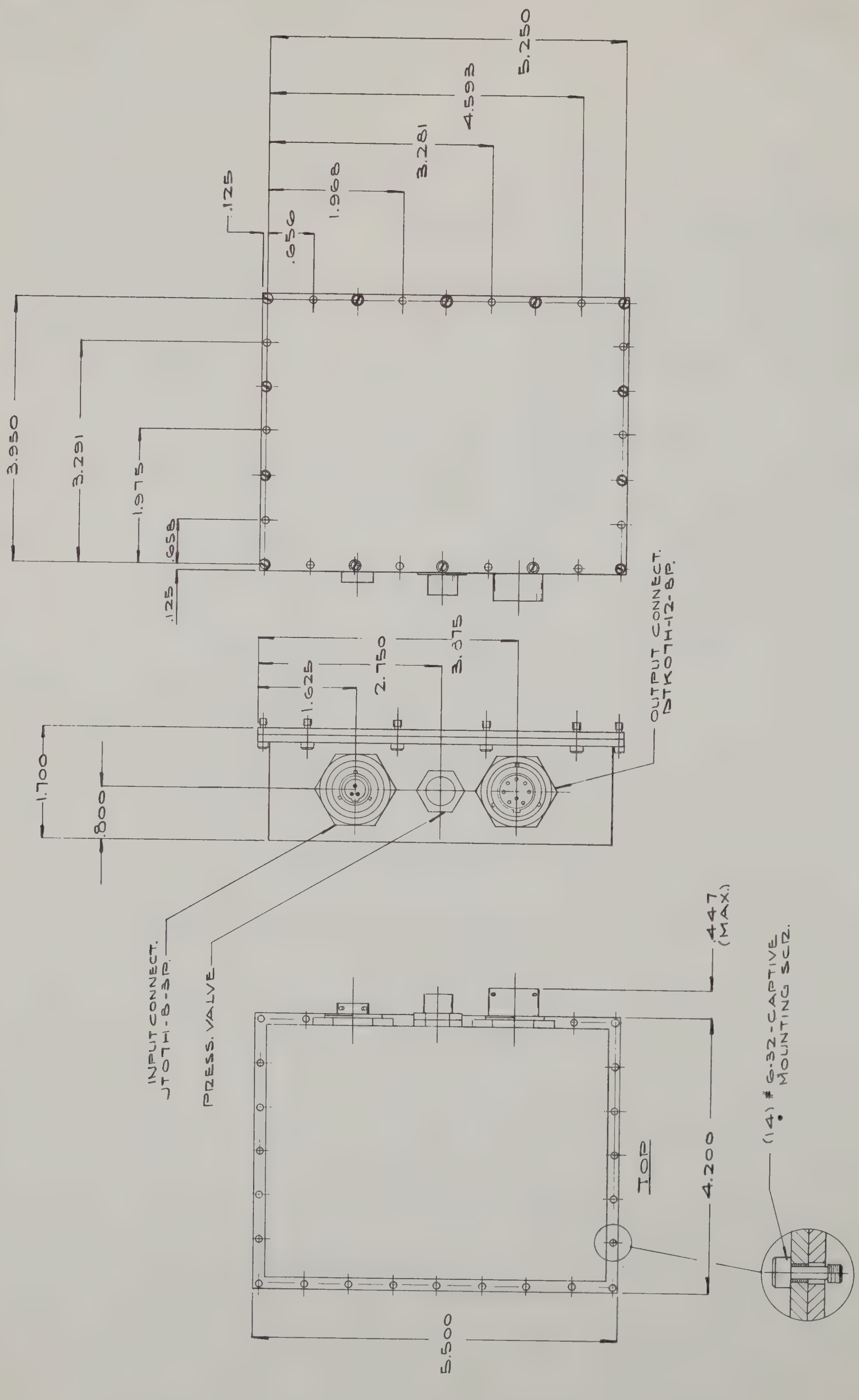
Plate Voltage	600, 650 or 700 Vdc, selectable by internal wiring, at 90 to 150 mA
Accuracy, (at nominal input, 125 mA)	±5%
Line Regulation	±5%
Load Regulation	±5%
Ripple (including spikes), maximum	3%
Heater Voltage	6.0 Volts, 1.0 Amperes
Line Regulation	±3%
Ripple (including spikes), maximum	10%
Bias Voltage	A constant-current, adjustable bias voltage is provided for operation of Eimac EM4539, EM4596 and similar amplifiers.
Input Voltage	28^{+8}_{-4} Volts dc
Overvoltage, maximum	43 Vdc
Input Transients, maximum	80 volts for 20 microseconds
Input Ripple, Maximum	3V rms, DC — 20 Kc, superimposed on 24-32 Vdc input
Input reversal is withstood without damage.	
Interference	Meets MIL-I-6181D
Efficiency, Minimum	70%
Life, Continuous or intermittent operation, 95% probability, 60% confidence	1000 hours

MECHANICAL

Size, Overall (excluding connectors)	1.7″ x 4.2″ x 5.5″
Weight	2.5 pounds
Mounting	on 4″ x 5″ surface, to heat sink (not included)
Cooling	Conduction
Pressurization	30 Psia
Connectors: Input	Bendix JT07H-8-3P
Output	Deutsch DTK07H-12—8-P

ENVIRONMENTAL

Temperature (at mounting surface)	–54°C to +95°C
Altitude (3 hour duration)	Any
Vibration	20 g peak to 2 KHz, Curve E, Fig. 514-3, MIL-STD-810 0.3 G^2/cps Random, Curve F, Fig. 514-4, MIL-STD-810 20 g peak, to 2 KHz, Category II, MIL-E-5400
Acceleration (Sustained)	-30 g, 5 minutes, three mutually perpendicular axes
Shock	50 g, Method 516, Proc. I, MIL-STD-810 100 g, Sawtooth, Proc. V, MIL-STD-810 Three mutually perpendicular axes


5.250
4.593
3.281
1.968
.656
.125
3.950
3.291
1.975
.658
.125
3.375
2.750
1.625
1.700
.800
OUTPUT CONNECT.
BTK07H-12-8P.
INPUT CONNECT.
JT07H-8-3P.
PRESS. VALVE
.447
(MAX.)
(14) # 6-32-CAPTIVE
MOUNTING SCR.
TOP
4.200
5.500

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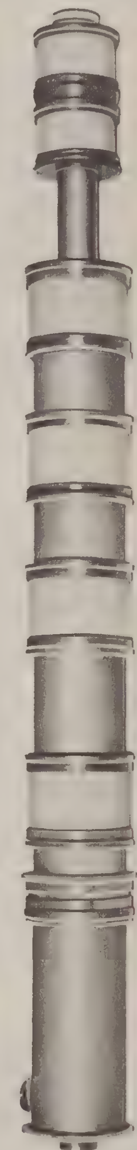
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X602K

POWER AMPLIFIER L-BAND KLYSTRON



The Eimac X602K is a four-cavity, magnetically focused, power-amplifier klystron designed for pulse service at frequencies from 375 to 500 megacycles. Under narrow-band conditions this tube will deliver a minimum pulse output power of 150 kilowatts at an average output power level of 75 kilowatts with a power gain of at least 45 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage.

All tuning is accomplished outside the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits external cavity loading for wide-band applications. For spares or replacements, only the basic klystron, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-142 has been designed for use with the X602K to cover the specified frequency range. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an Eimac Air-System Socket. The H-142 Klystron Amplifier Circuit Assembly conforms generally to Military Environmental Specification MIL-E-4970A (USAF) and the general Military Specification MIL-E-4158B (USAF), for electronic ground equipment.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage (±5%)	11	volts
	Current	47.5	amperes
	Maximum Starting Current	100	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	Voltage (Nominal)	9.1	volts
	Current	36	amperes

Power Gain: (Narrow-Band)	45	decibels
Minimum Pulse Output Power	150,000	watts
Average Output Power	75,000	watts
Frequency Range (H-142 Circuit Assembly)	375 to 500	megacycles

MECHANICAL

Operating Position	Vertical, cathode end up
RF Input Coupling	Type "N" coaxial fitting
RF Output Coupling	50-ohm, 6-1/8" line
Weight (Tube Only)	196 pounds
Shipping Weight (Approximate)	410 pounds

MECHANICAL (continued)

Cooling: Water or 60% Ethylene Glycol solution and Forced Air

	Flow Rate	Pressure Drop
Cathode (SK-1000 socket)	*50 cfm air	1 inch H_20
Output Cavity	*50 cfm air	6 inches H_20
Five Drift-Tube sections in series	10 gpm	23 psi
Collector	50 gpm	59 psi

MAXIMUM RATINGS

DC BEAM VOLTAGE	50	KILOVOLTS
AVERAGE BEAM CURRENT	5	AMPERES
PULSE BEAM CURRENT	9	AMPERES
DC FOCUS ELECTRODE VOLTAGE	-1000	VOLTS
PULSE BODY CURRENT	250	MILLIAMPERES
PULSE MODULATING ANODE VOLTAGE	50	KILOVOLTS
COLLECTOR DISSIPATION	170	KILOWATTS
SEAL TEMPERATURES	175	DEGREES C

TYPICAL OPERATION

(Narrow-Band, Pulse Amplifier in H-142 Magnetic Circuitry)

Frequency	390	megacycles
Pulse Output Power	155	kilowatts
Average Output Power	34	kilowatts
Drive Power	3.0	watts
Pulse Power Gain	47	decibels
Pulse Input Power	346	kilowatts
Average Input Power	76	kilowatts
DC Beam Voltage	45	kilovolts
Pulse Modulating Anode Voltage	45	kilovolts
Average Beam Current	1.69	amperes
Pulse Beam Current	7.7	amperes
Pulse Beam Efficiency	44.8	percent
DC Body Current	40	milliamperes
Focus Electrode Voltage	-400	volts
Duty	22	percent

* At Sea Level with 20° C inlet air temperature.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EITEL-McCULLOUGH, INC.

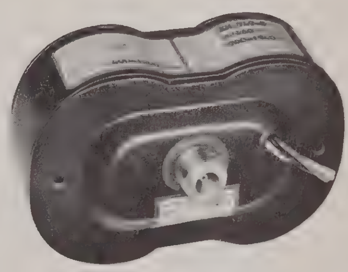
EM-747

Voltage Tunable Magnetron

Frequency 400—1200 Mc

Minimum Output Power 50 mW Min.

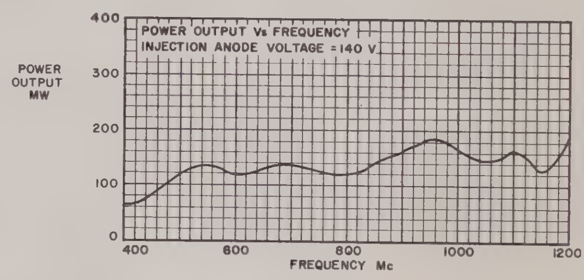
TYPICAL PERFORMANCE



L-BAND OSCILLATOR

ELECTRICAL

Frequency Range	0.4-1.2 kMc
Anode Voltage	660-1980 V
Cathode Current	2-8 mA
Typical Output Power	75-250 mW
Anode FM Sensitivity	.65 Mc/V
Injection Anode Voltage	200 V
Injection Anode Current	0 mA
Heater Voltage (AC or DC)	6.3 V
Heater Current (AC or DC)	0.8 A
Load Impedance	50 ohms
Service	cw



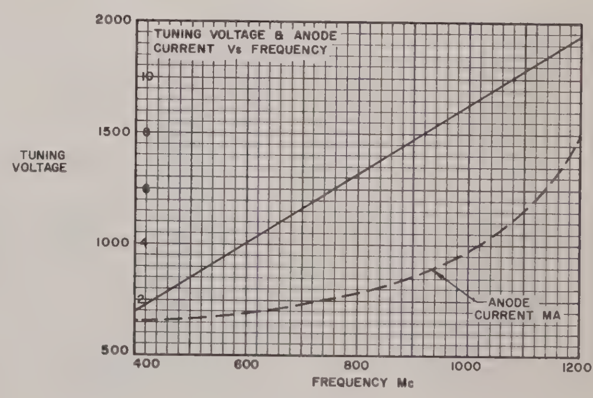
*MAXIMUM RATINGS

Anode Voltage	2000 V
Cathode Current	20 mA
Injection Anode Voltage	500 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.0 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	1.6 inches
Length	4.5 inches

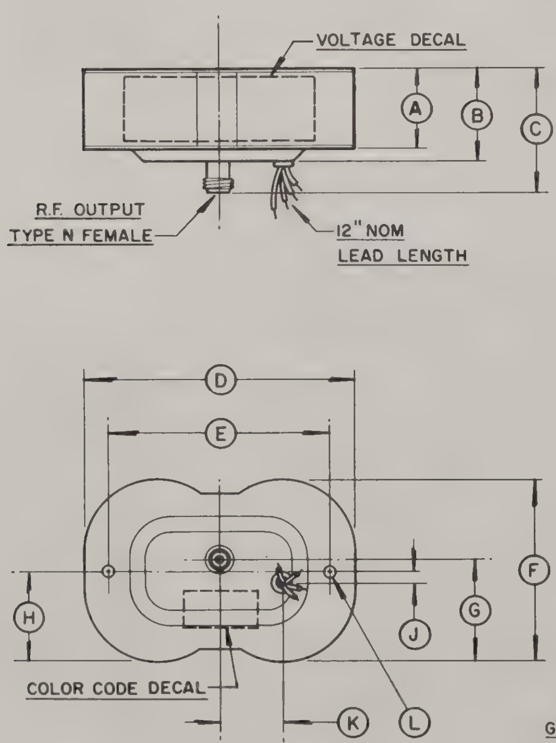
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the EM-747 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM-747 package is typically .02% of the operating frequency per degree Centrigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centrigrade. A positive change in temperature will always produce a positive change in frequency. On special order, temperature compensation of .008% of the operating frequency per degree Centigrade can be provided.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.

CONNECTIONS
GROUND - GREEN
HEATER - WHITE
HEATER CATHODE - BLACK
INJECTION ANODE - YELLOW

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EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

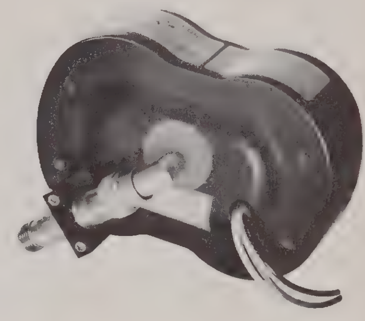
X-1083B

Low Noise Voltage Tunable Magnetron

Frequency 320 - 525 Mc

Minimum Power Output 32 mW

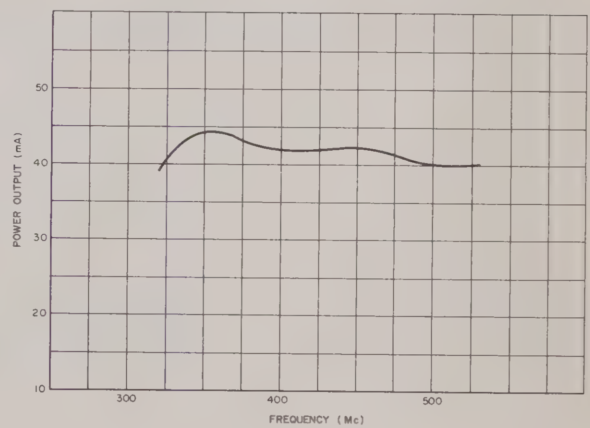
TYPICAL PERFORMANCE



P-BAND OSCILLATOR

ELECTRICAL

Frequency Range - - - - - -	320-525 Mc
Anode Voltage - - - - - - -	1230-2000 V
Cathode Current - - - - - -	0.5-1.5 mA
Typical Output Power - - - - -	30-50 mW
Anode FM Sensitivity - - - - -	.26 Mc/V
Injection Anode Voltage - - - -	100 V
Injection Anode Current - - - -	0.02 mA
Heater Voltage (AC) - - - - -	6.3 V
Heater Current (AC) - - - - -	0.8 A
Load Impedance - - - - - -	50 ohms
Service - - - - - - - - -	cw
Noise - - - - - - - - -	−85 db (See Note 5)
VSWR (max) - - - - - - -	2:1



MAXIMUM RATINGS*

Anode Voltage - - - - - - -	2300 V
Cathode Current - - - - - -	10 mA
Injection Anode Voltage - - - -	+300 V
Injection Anode Current - - - -	1 mA

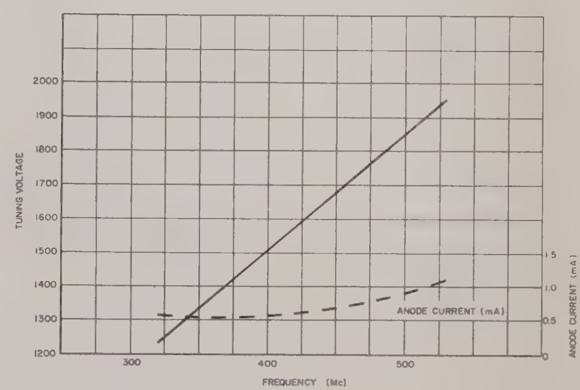
*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position - - - - -	Any
Cooling - - - - - - - - -	Conduction
Electrical Connection - - - -	Flexible Leads
RF Output Coupling - - - - -	Type TNC Jack (See Outline Drawing)
Weight - - - - - - - - -	3.5 Pounds

ENVIRONMENTAL

Vibration - - - - - - - -	10G-(to 2kc)
Shock - - - - - - - - -	100G-(11ms)
Altitude - - - - - - - -	70,000 ft.



OUTLINE DIMENSIONS

Height - - - - - - - - -	3.1 inches
Width - - - - - - - - -	2.5 inches
Length - - - - - - - - -	4.6 inches

APPLICATION NOTES

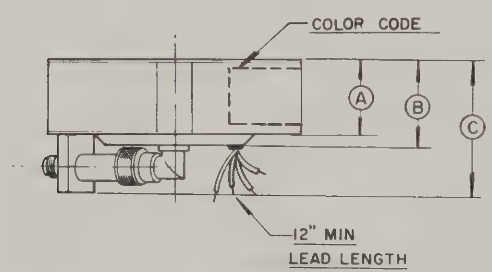
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

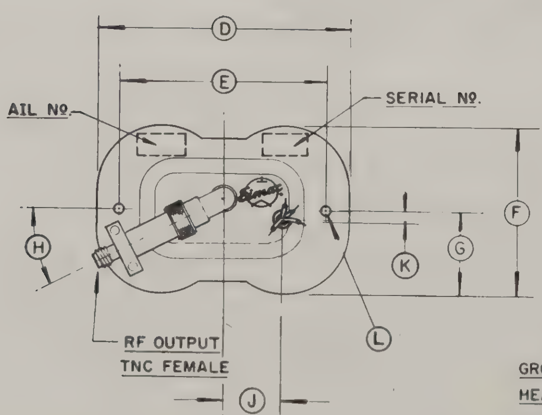
3. TEMPERATURE STABILITY: The permanent magnet for the X-1083-B has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficent for the X-1083-B package is typically .008% of the operating frequency per degree Centrigrade. Thus, for an operating frequency of 400 megacycles, the temperature/frequency coefficient is typically 32 kilocycles per degree Centrigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. NOISE: 5 points as measured using a 60 Mc If, both sidebands and a 2 Mc bandpass (this measuring technique is one of many methods available. Other methods will be entertained.)



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN	MAX.	NOM.
A			1.375
B			1.562
C			2.500
D		4.600	
E	3.640	3.671	
F		3.100	
G			1.500
H			27°
J			1.062
K			.375
L			.173 D.



CONNECTIONS
GROUND - GREEN
HEATER - WHITE
HEATER CATHODE - BLACK
INJECTION ANODE - YELLOW

X-1088-B

Low Noise Voltage Tunable Magnetron

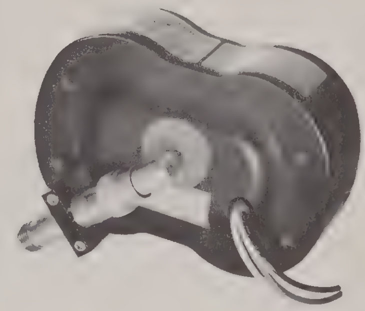
Frequency 520 - 925 Mc

Minimum Output Power 32 mW

Eimac

EITEL-McCULLOUGH, INC.

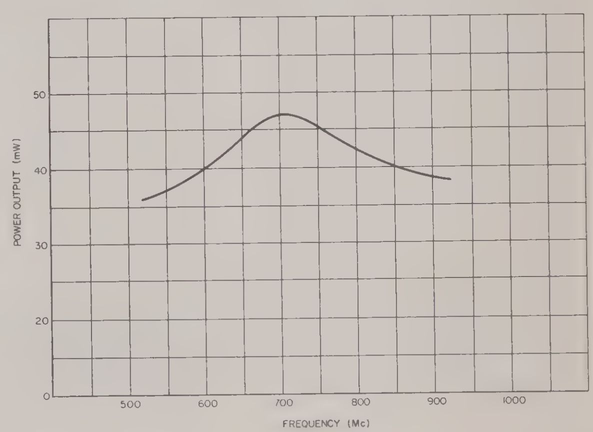
TYPICAL PERFORMANCE



P-BAND OSCILLATOR

ELECTRICAL

Frequency Range	520-925 Mc
Anode Voltage	1000-2000 V
Cathode Current	2-4 mA
Typical Output Power	30-50 mW
Anode FM Sensitivity	.55 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.02 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
Noise	−85 db (See Note 5)
VSWR (max)	2:1



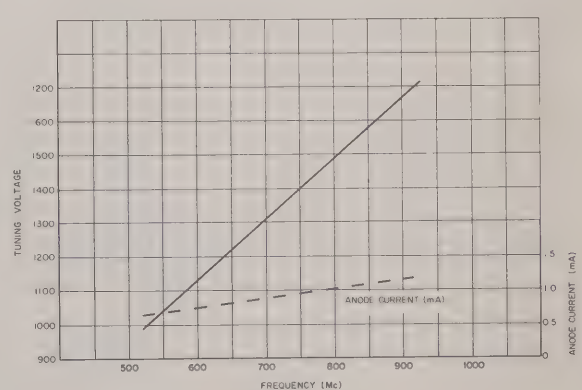
*MAXIMUM RATINGS

Anode Voltage	2300 V
Cathode Current	10 mA
Injection Anode Voltage	+300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type TNC Jack (See Outline Drawing)
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2 kc)
Shock	100G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3.1 inches
Width	2.5 inches
Length	4.6 inches

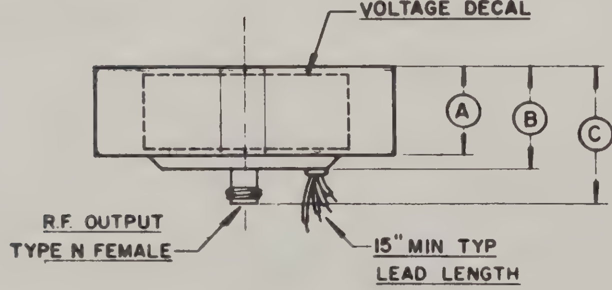
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

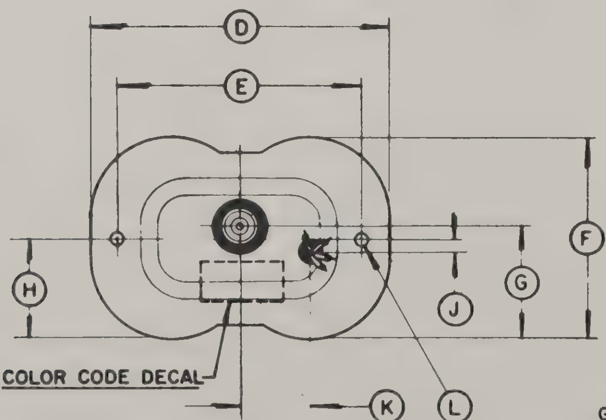
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray megnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1094 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1094 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 400 megacycles, the temperature/frequency coefficient is typically 32 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN	MAX	NOM
A			1.375
B			1.562
C			2.172
D		4.600	
E	3.640	3.671	
F		3.100	3.000
G			1.656
H			1.500
J			.375
K			1.000
L			.187 D.



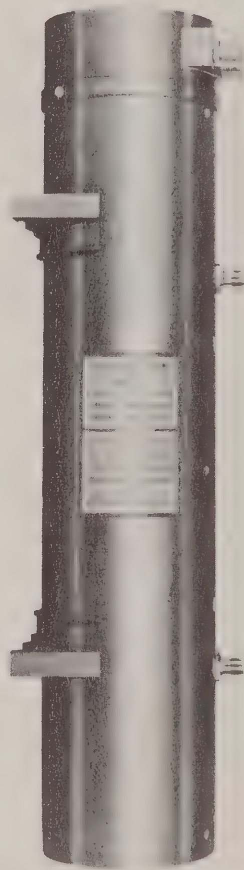
CONNECTIONS
GROUND - GREEN
HEATER - WHITE
HEATER CATHODE - BLACK
INJECTION ANODE - YELLOW

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 108

TRAVELING WAVE TUBE



The EM108 is an octave bandwidth pulse PPM focused TWT capable of delivering 1.0 kw of power from 2.0–4.0 Gc. This tube is of metal-ceramic construction designed for operation in severe environments. This tube contains a grid for modulating purposes.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Pulse Grid Voltage	+400 to −150 vdc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7500 Vdc
Peak Cathode Current	1.3 Adc
Grid Voltage (Beam off)	−90 Vdc
Grid Voltage (Beam on)	+200 Vdc
Duty Cycle	2%
Frequency Range	2.0–4.0 Gc
Small Signal Gain—Minimum	36 db
Peak Saturated Power Out—Minimum	1.0 kw
Saturated Gain—Minimum	30 db
Grid Capacitance (to all other elements)	15 picofds.

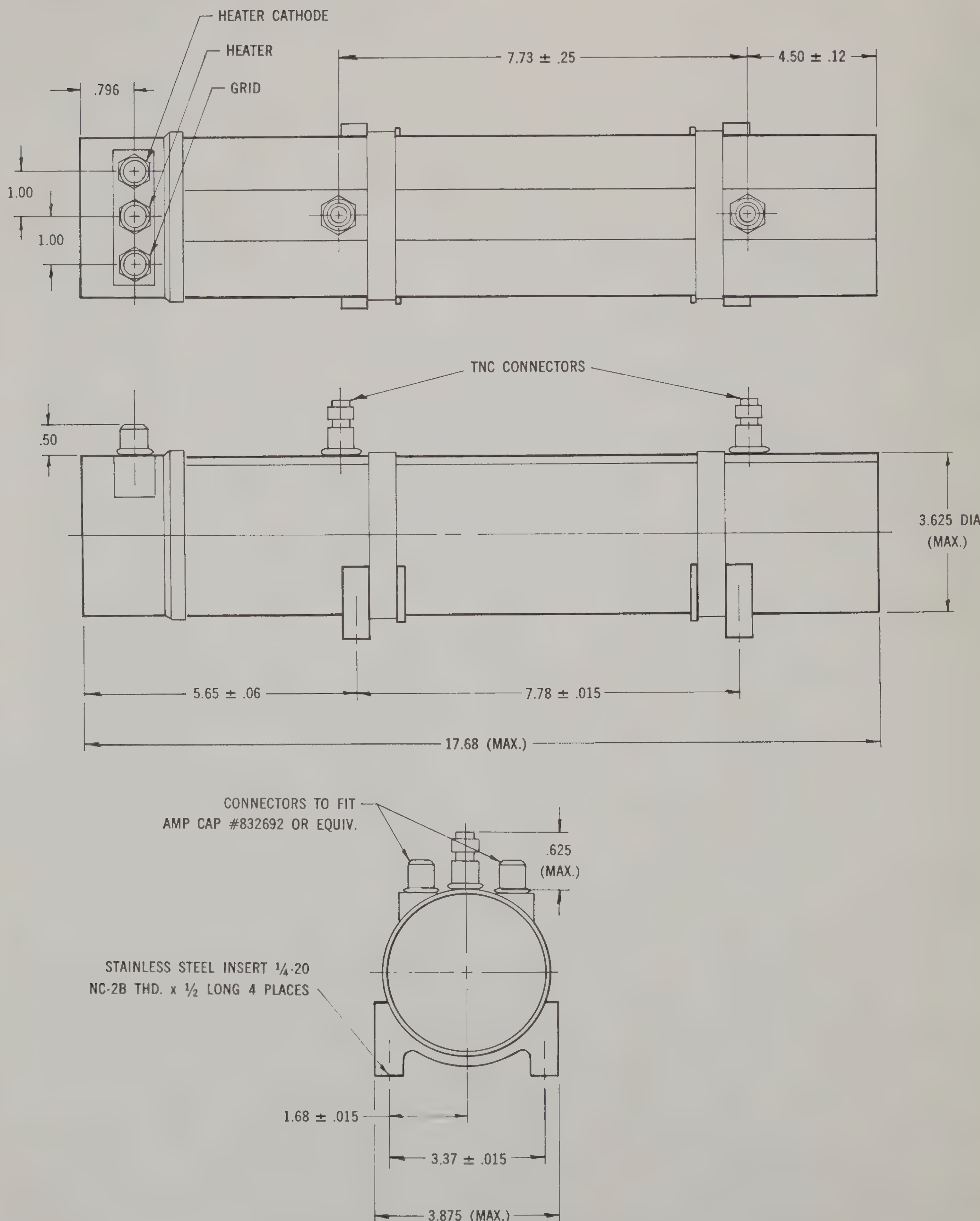
ENVIRONMENTAL SPECIFICATIONS

Complies with MIL-5400 Class II Equipment	
Temperature	−65°C to +125°C

MECHANICAL SPECIFICATIONS

Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

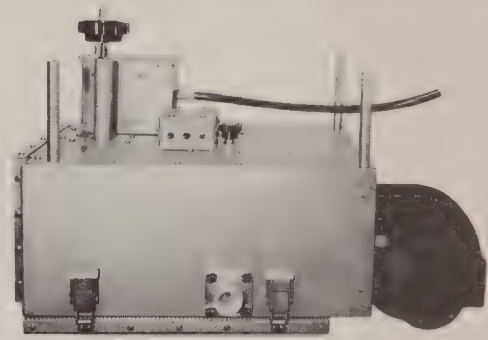

HEATER CATHODE
HEATER
GRID
.796
1.00
1.00
7.73 ± .25
4.50 ± .12
TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)
CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT 1/4-20
NC-2B THD. x 1/2 LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

Eimac
EITEL-McCULLOUGH, INC.

EM4500

CAVITY AMPLIFIER
145-150 Mc

The Eimac EM4500 is a cavity amplifier incorporating the Eimac 4CX1000K tetrode. It is designed for use as a linear amplifier in a transmitter output stage. Front panel tuning controls are provided.



CHARACTERISTICS

ELECTRICAL

Frequency, continuously tunable		145-150 Mc
RF Power Output		300 watts*CW
RF Drive Power Required		3W*
Power Supply Requirements (Typical):	Voltage	Current
Anode, maximum	3000 V	500 mA*
Grid	-10 to -100 V	-0.25 to 0.75 mA
Heater	6.0 V	20 A
Tube Type		Eimac 4CX1000K
Load Impedance		50 ohms
Bandwidth		20 KC minimum at 3 db
Modulation		0-100% AM, 0-10,000 CPS

MECHANICAL

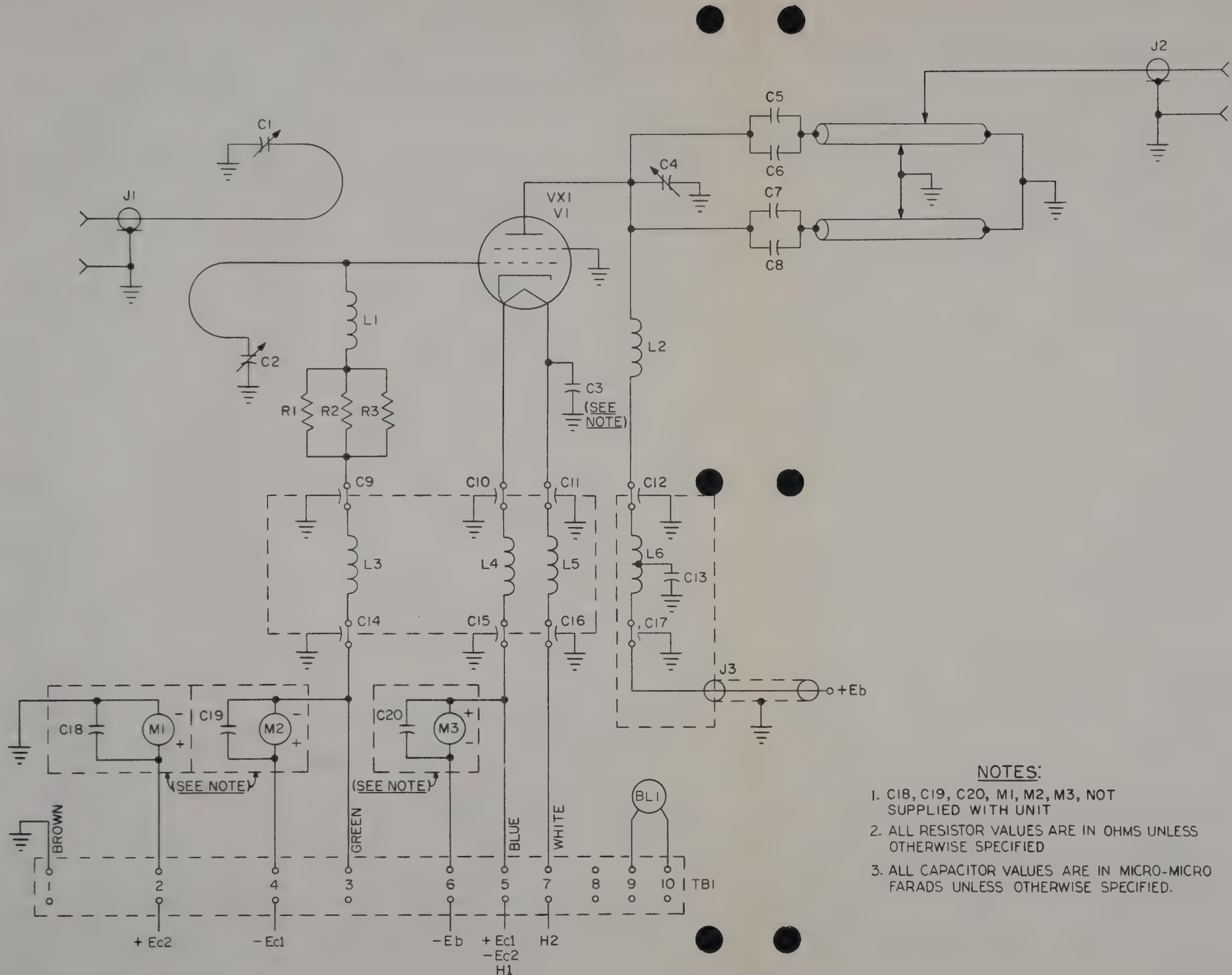
Mounting	Standard 19" relay rack Panel
Size	height -- 16 inches width -- 14 inches depth -- 12 inches
Operating controls	Tuning knobs provided
Cooling required	50 CFM at 0.5" water
Connectors	Input - - Type N Female Output - Type LC Female

ENVIRONMENTAL

Temperature	-10 to +50°C (+14 to +122°F)
Altitude	to 12,000 feet

*Up to 1 KW output can be provided with 15 watts drive and 600 mA anode current.

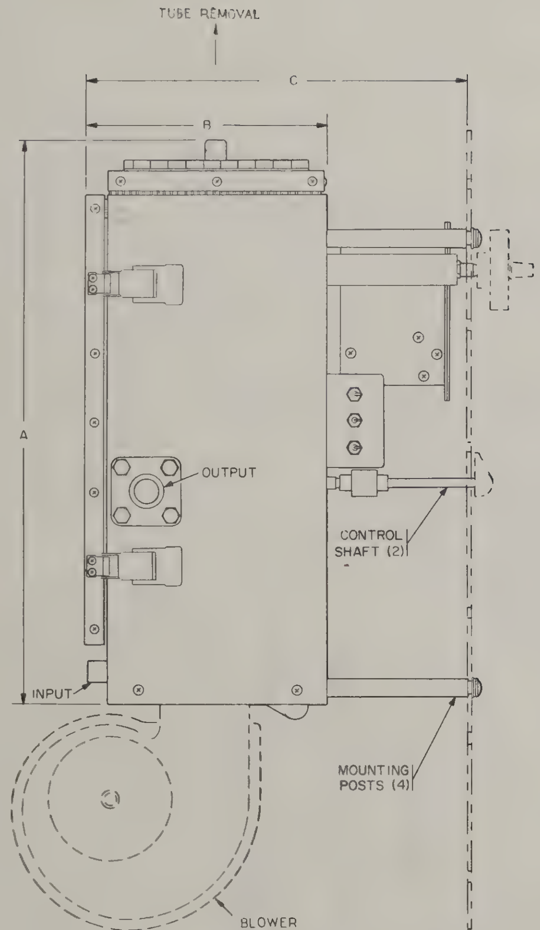
EM4500



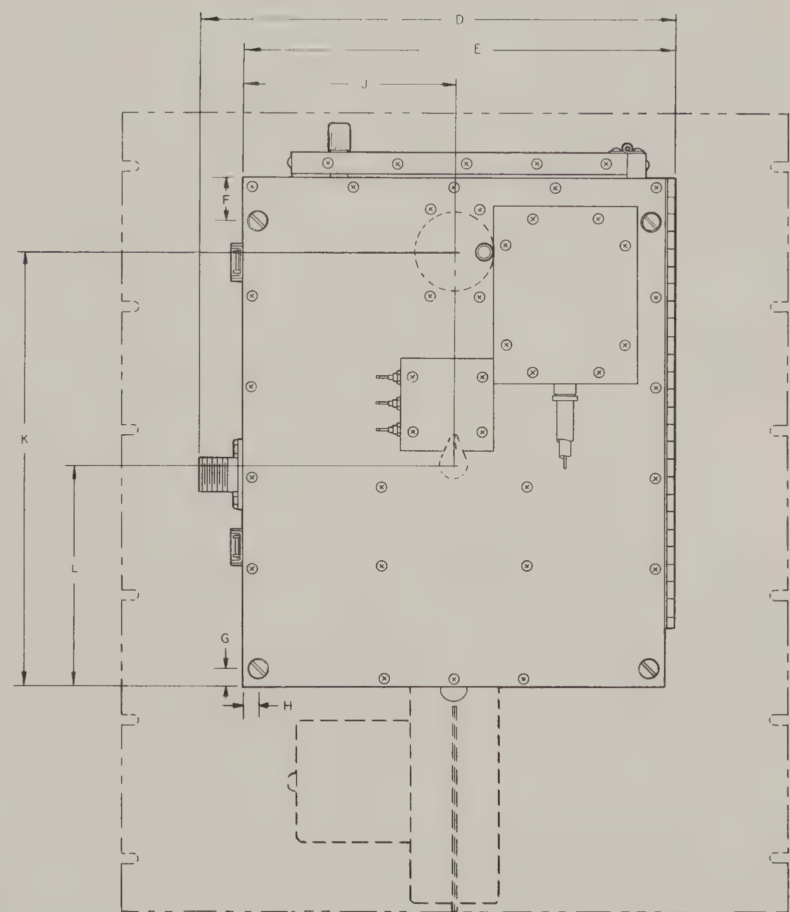
NOTES:

1. C18, C19, C20, M1, M2, M3, NOT SUPPLIED WITH UNIT
2. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED
3. ALL CAPACITOR VALUES ARE IN MICRO-MICRO FARADS UNLESS OTHERWISE SPECIFIED.

REFERENCE SCHEMATIC ONLY



SIDE VIEW



FRONT VIEW

DIMENSION DATA		
REF	MIN	MAX
A	15.875	16.125
B	7.110	7.140
C	11.093	11.157
D	13.454	13.546
E	12.220	12.280
F	1.202	1.298
G	.484	.516
H	.359	.391
J	5.953	5.984
K	11.922	11.953
L	6.234	6.266

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4K3SJ

POWER AMPLIFIER S-BAND KLYSTRON

The Eimac 4K3SJ is an air cooled, permanent magnet focused, power-amplifier klystron designed to operate at frequencies from 1700 to 2400 megacycles. It will deliver a minimum output power of 1 kilowatt with a minimum power gain of 40 decibels. The 4K3SJ is intended for use in applications where light weight and compactness are essential.

FEATURES

FREQUENCY - - - - 1700-2400 Mc

MINIMUM OUTPUT POWER - - - 1 kW

MINIMUM POWER GAIN - - - 40 db

PERMANENT MAGNET FOCUSING

FOUR INTEGRAL CAVITIES

LOW NOISE LEVEL

FIXED INPUT AND OUTPUT COUPLING

TWO LIFTING HANDLES
FOR EASE OF HANDLING

INSTANT FAULT RECYCLING

CHARACTERISTICS

ELECTRICAL

Cathode:	Impregnated, Unipotential		
	Starting Time	3	minutes
Heater:	Voltage	6	volts
	Current	4.5	amperes
	Maximum Starting Current	9	amperes

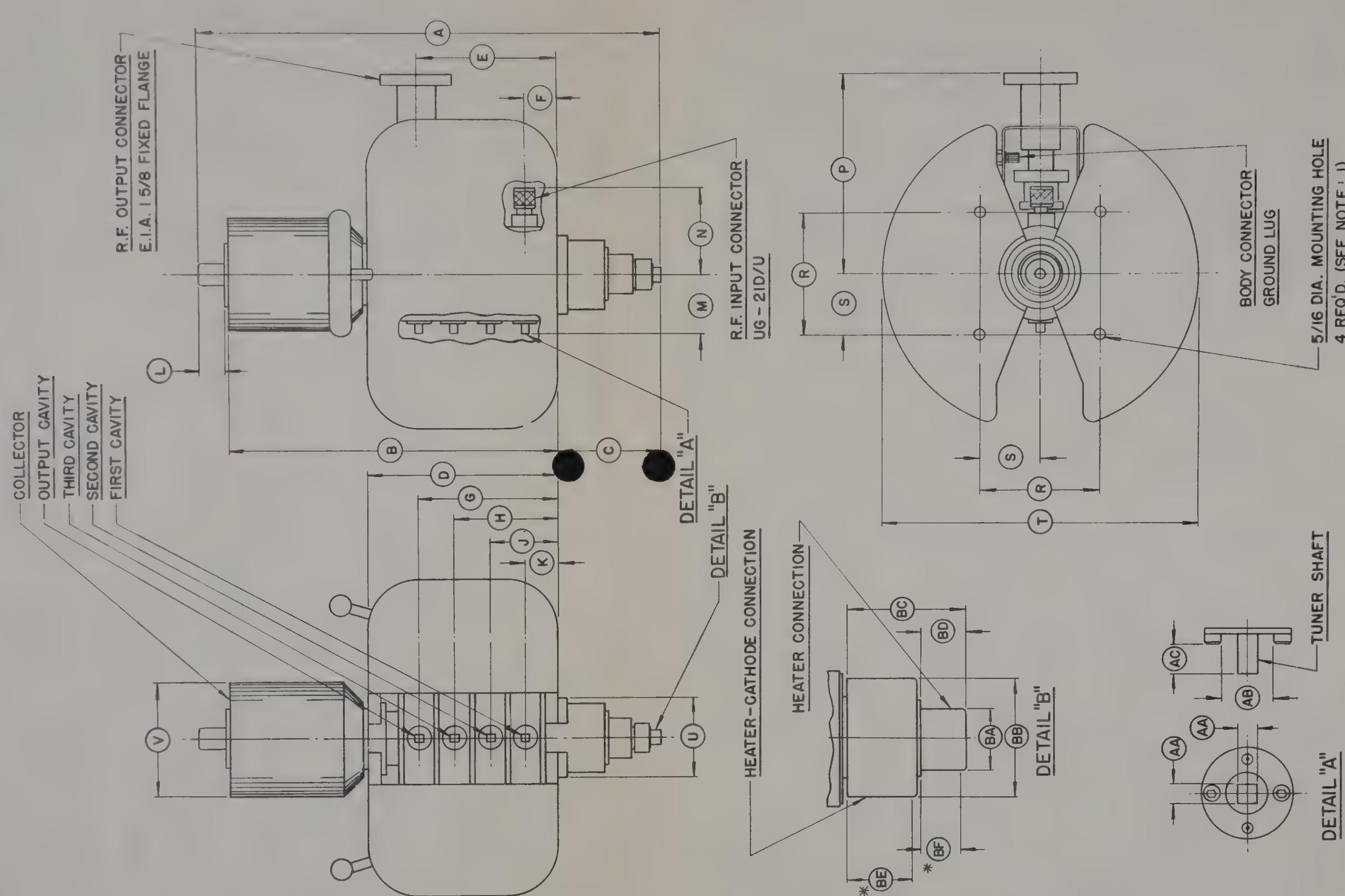
MECHANICAL

Operating Position (preferred)	Vertical,	cathode down
Cavity Tuning Torque (maximum)	12	inch pounds
Cooling: Forced Air (20°C at sea level)		
Collector Flow	200	cfm
Collector Pressure Drop	1.5	inches H_2O

Body and cathode seals require cooling only at higher temperatures or lower pressures.

4K3SJ KLYSTRON

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A			19.000
B	13.475		
C	4.544		
D			7.574
E	5.820		
F	1.470		
G	5.820		
H	4.370		
J	2.920		
K	1.470		
L			.750
M	2.472		
N	3.475		
P	7.910		
R		4.888	5.012
S		2.444	2.506
T			13.196
U			3.042
V	4.383		
AA		.248	.252
AB		.647	
AC		.340	
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		530	
BE		.830	
BF		.450	



NOTES:
1. KEEP MAGNETIC MATERIALS AT LEAST SIX INCHES AWAY FROM MAGNET: OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT.

MECHANICAL (continued)

Maximum Dimensions:		
Length	18.4	inches
Width	13.25	inches
Depth	14	inches
RF Input Coupling	UG-21 D/U Connector	
RF Output Coupling	1-5/8 inch, 50-ohm line	
Weight (Klystron and Magnet)	85	pounds

MAXIMUM RATINGS

DC BEAM VOLTAGE	7.0	KILOVOLTS
DC BEAM CURRENT	0.6	AMPERE
DC BEAM INPUT POWER	4	KILOWATTS
COLLECTOR DISSIPATION	4	KILOWATTS
CATHODE SEAL TEMPERATURE	150	DEGREES C
LOAD VSWR	2:1	

TYPICAL OPERATION—TUNED FOR MAXIMUM EFFICIENCY

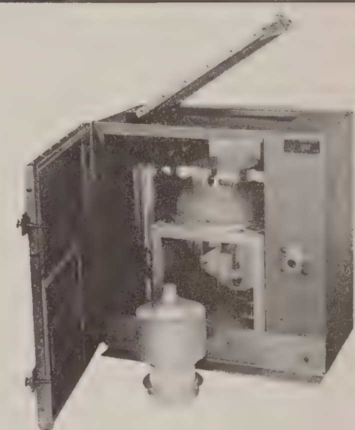
Frequency	1700	2000	2400	megacyles
Output Power	1.17	1.08	1.03	kilowatts
Driving Power	20	25	30	milliwatts
Gain	47.6	46.3	45.3	decibels
DC Beam Voltage	6	6	6.2	kilovolts
DC Beam Current	0.54	0.54	0.56	ampere
Beam Power Efficiency	36.2	33.4	31.8	percent
3 db Bandwidth	4	4.5	6	megacycles

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EM4501

CAVITY AMPLIFIER
145-150 Mc

EITEL-McCULLOUGH, INC.



The Eimac EM4501 is a cavity amplifier incorporating the Eimac 4CX3000A tetrode. It is designed for use as a power amplifier in a transmitter output stage.

CHARACTERISTICS

ELECTRICAL

Frequency	145-150 Mc	
RF Power Output	3 kW CW	
RF Drive Power Required	175 W	
Power Supply Requirements (Typical):	Voltage	Current
Anode, Maximum	4500 V	1.1A
Screen Grid, Maximum	300 V	125 mA
Control Grid, Maximum	150 V	55 mA
Heater	9.0 V	45 A
Tube Type	Eimac 4CX3000A	
Load Impedance	50 ohms	
Load VSWR, Maximum	1.5:1, any phase	
Bandwidth	20 KC Minimum at 3 db	
Modulation	0-100% AM, 0-10,000 CPS	

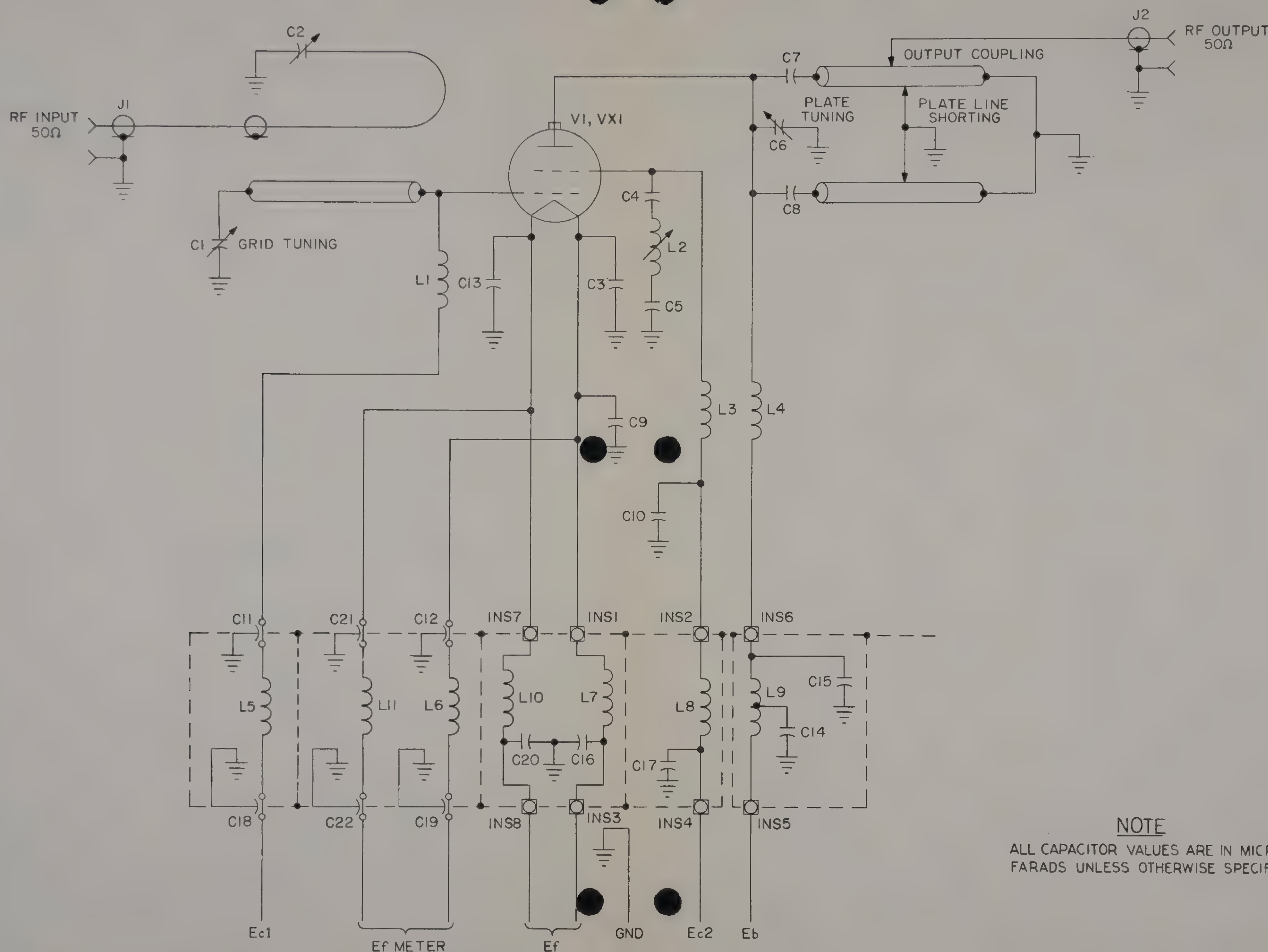
MECHANICAL

Mounting	Standard 19" relay rack panel
Size	Height - 18 inches
	Width - 15-3/4 inches
	Depth - 14-7/8 inches
Cooling Required	170 CFM at 1.6" water
Connectors	Input - - Type N Female
	Output -- Type LC Female

ENVIRONMENTAL

Temperature	-10 to +50°C (+14 to+122° F)
Altitude	to 12,000 feet

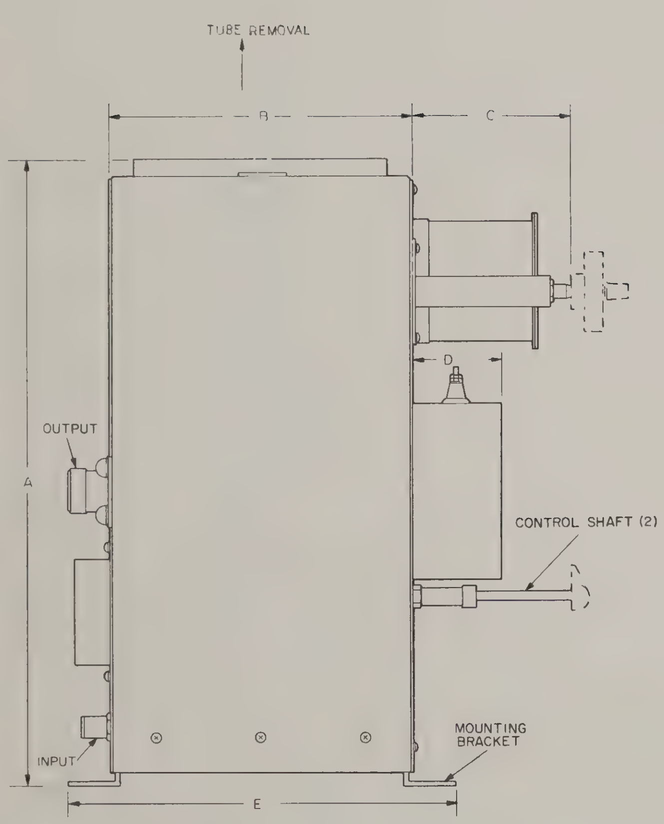
 EM4501



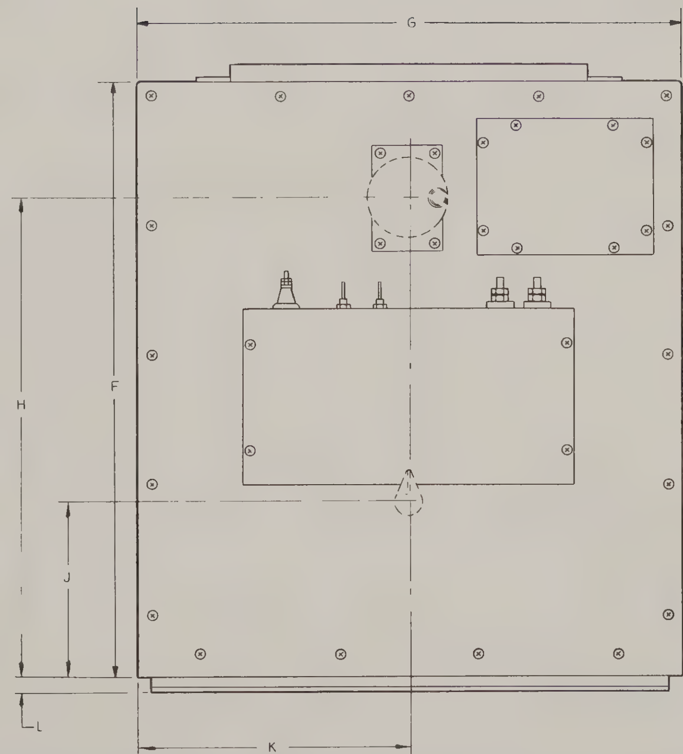
NOTE

ALL CAPACITOR VALUES ARE IN MICRO-MICRO FARADS UNLESS OTHERWISE SPECIFIED

REFERENCE SCHEMATIC ONLY



SIDE VIEW



FRONT VIEW

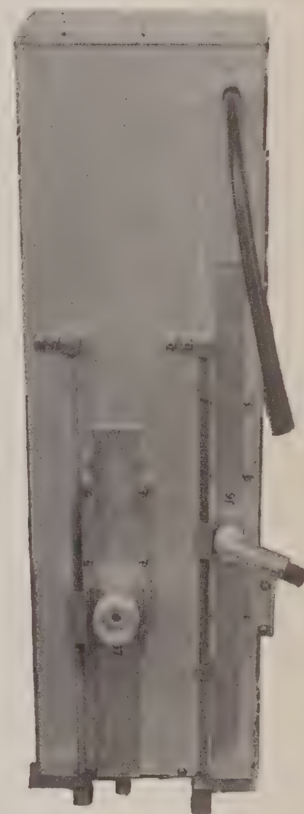
DIMENSION DATA		
REF	MIN	MAX
A	18.110	18.140
B	8.606	8.650
C	4.953	5.047
D	2.484	2.516
E	11.110	11.140
F	16.921	16.953
G	15.359	15.391
H	13.671	13.691
J	4.984	5.016
K	7.672	7.703
L	.359	.391

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4506

CAVITY AMPLIFIER
122-150 Mc



The Eimac EM4506 is a cavity amplifier incorporating the Eimac 4CX1000K tetrode. It is designed for use as an intermediate stage or the output stage of an FM transmitter.

CHARACTERISTICS

ELECTRICAL

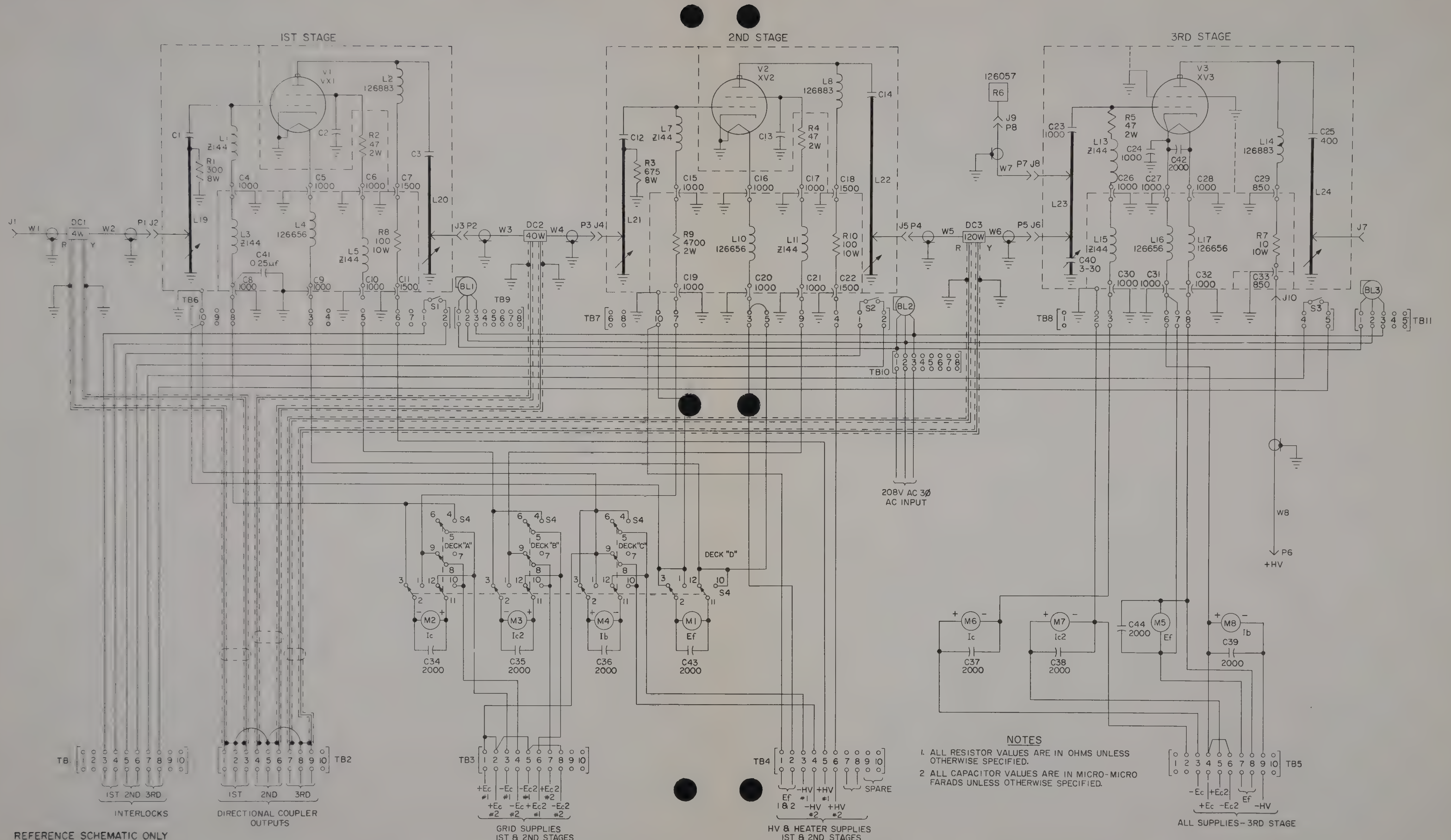
Frequency		122-150 Mc
RF Power Output		1 kW CW
RF Drive Power Required		30 Watts
Power Supply Requirements (Typical):	Voltage	Current
Anode, Maximum	3 KV	1 A
Screen Grid, Maximum	250-350 V	-100 to +125 mA
Control Grid, Maximum	-90 to -120 V	-50 to +0.75 mA
Tube Type		Eimac 4CX1000K
Load Impedance		50 ohms
Bandwidth		2 Mc at 1.5 db
Modulation		FM

MECHANICAL

Mounting	Standard 19" relay rack panel
Size	Height - 24 inches
	Width - 15 inches
	Depth - 12 1/2 inches
Cooling	Blower included
Connectors	Input -- Type N Female
	Output -- Type LC Female

ENVIRONMENTAL

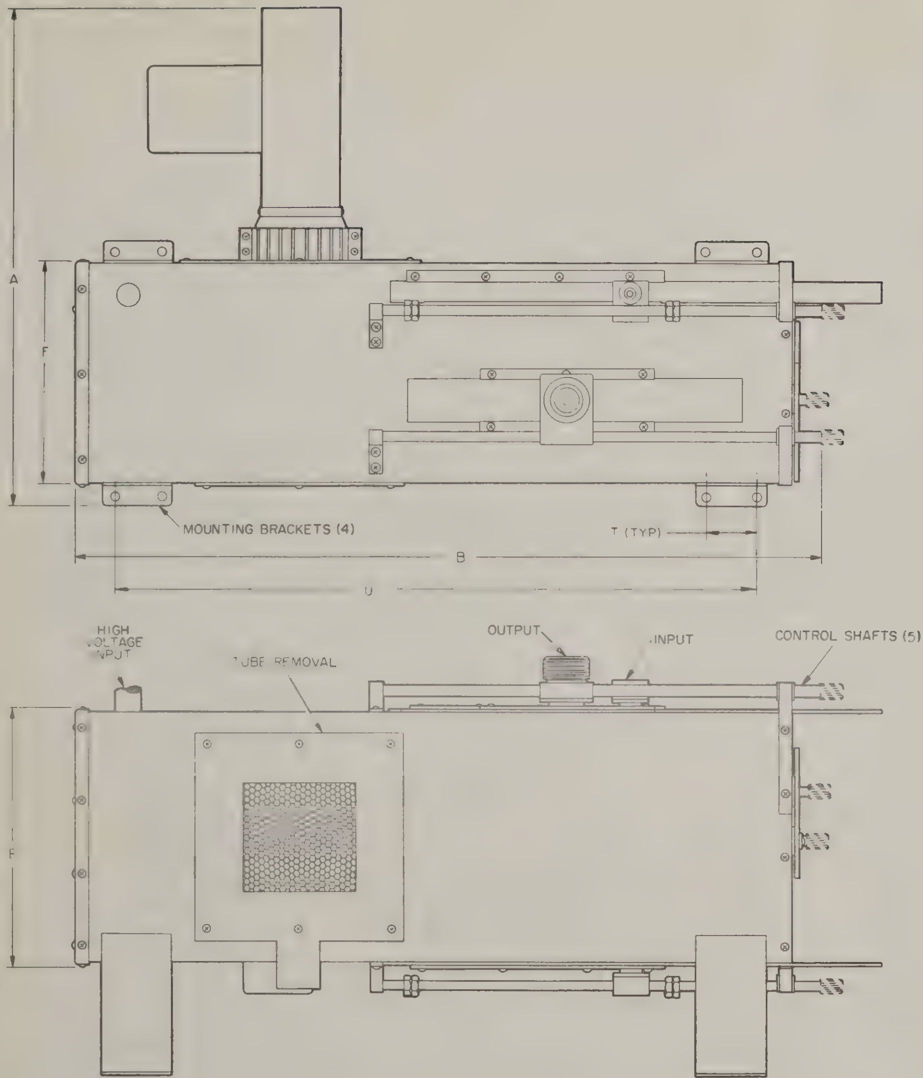
Temperature	-10 to +50° C (+14 to +122° F)
Altitude	to 12,000 feet



NOTES

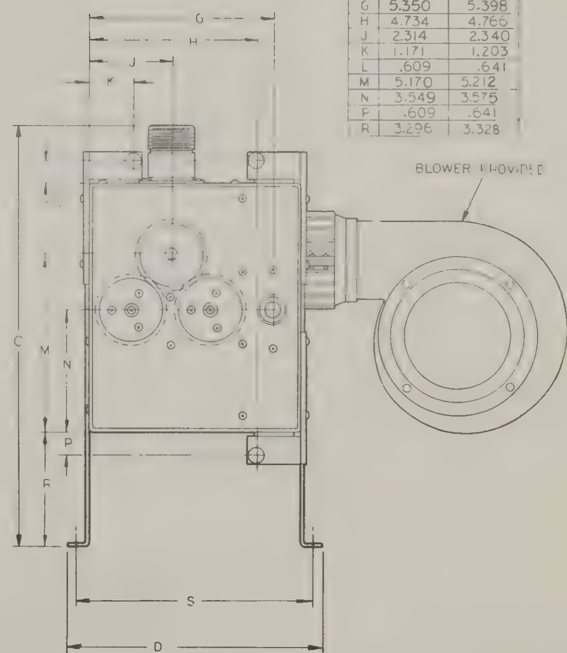
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES ARE IN MICRO-MICRO FARADS UNLESS OTHERWISE SPECIFIED.

REFERENCE SCHEMATIC ONLY



DIMENSION DATA		
REF	MIN	MAX
A	8.268	8.434
B	21.844	21.875
C	11.719	11.843
D	7.389	7.485
E	7.171	[illegible]
F	6.266	6.234
G	5.350	5.398
H	4.734	4.766
J	2.314	2.340
K	1.171	1.203
L	.609	.641
M	5.170	5.212
N	3.549	3.575
P	.609	.641
R	3.296	3.328

DIMENSION DATA			
REF	MIN	MAX	NOM
S			6.937
T			1.500
U			18.500



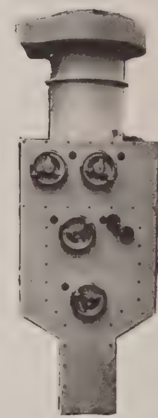
Eimac

EITEL-McCULLOUGH, INC.

EM4507

CAVITY AMPLIFIER

122-150 Mc



The Eimac EM4507 is a high power Cavity Amplifier designed for use as the final amplifier stage of an FM transmitter. It incorporates the Eimac 3CX10,000A7 zero bias triode in a grounded grid circuit. Front panel tuning controls are provided.

CHARACTERISTICS

ELECTRICAL

Frequency		122-150 Mc
RF Power Output		12 kW CW
RF Drive Power Required		800 Watts
Power Supply Requirements (Typical):	Voltage	Current
Anode, Maximum	6 KV	3.5 A
Heater	7.5 V	102 A
Tube Type		Eimac 3CX10,000A7
Load Impedance		50 ohms
Bandwidth		2 Mc at 1.5 db
Modulation		FM-CW

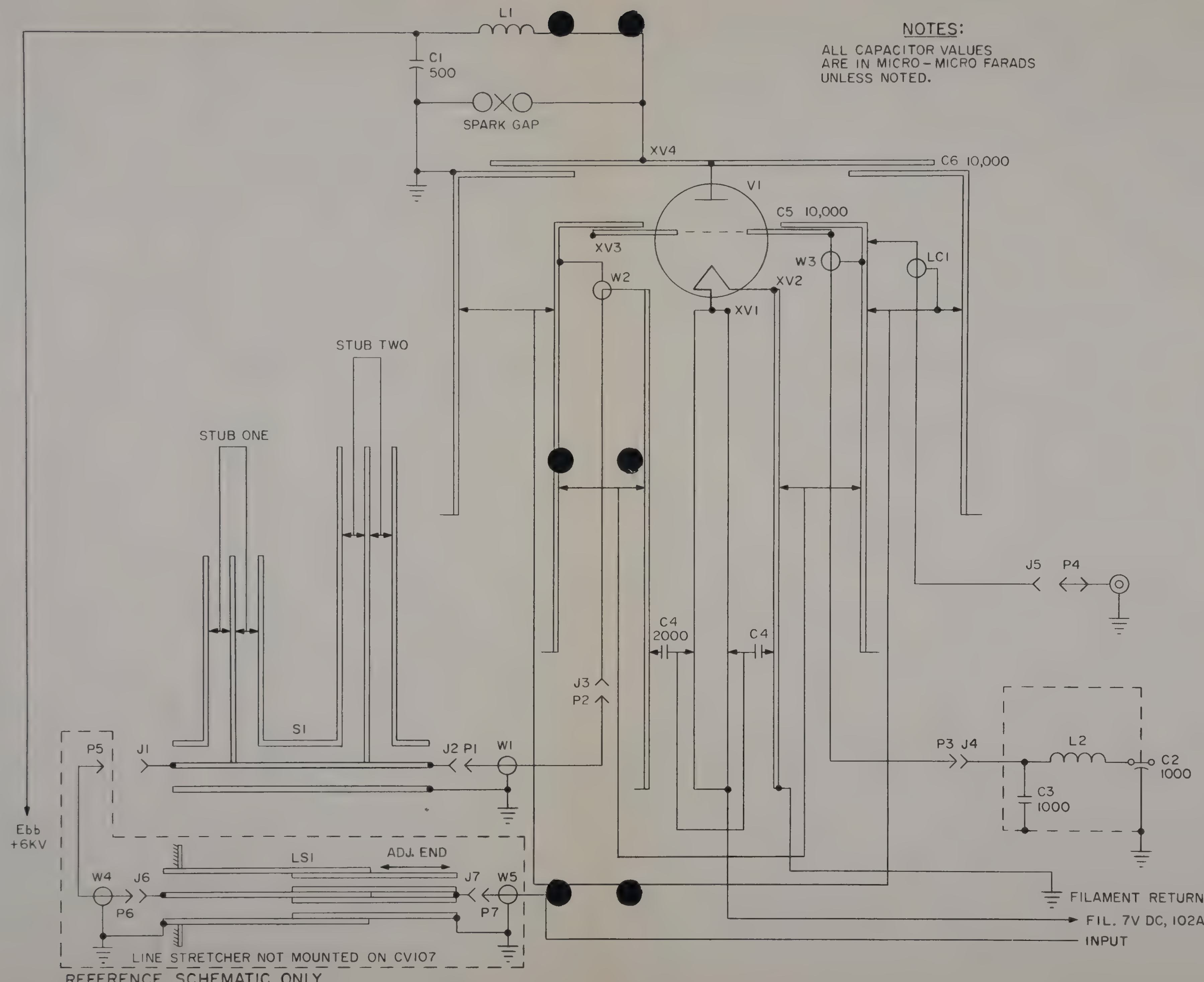
MECHANICAL

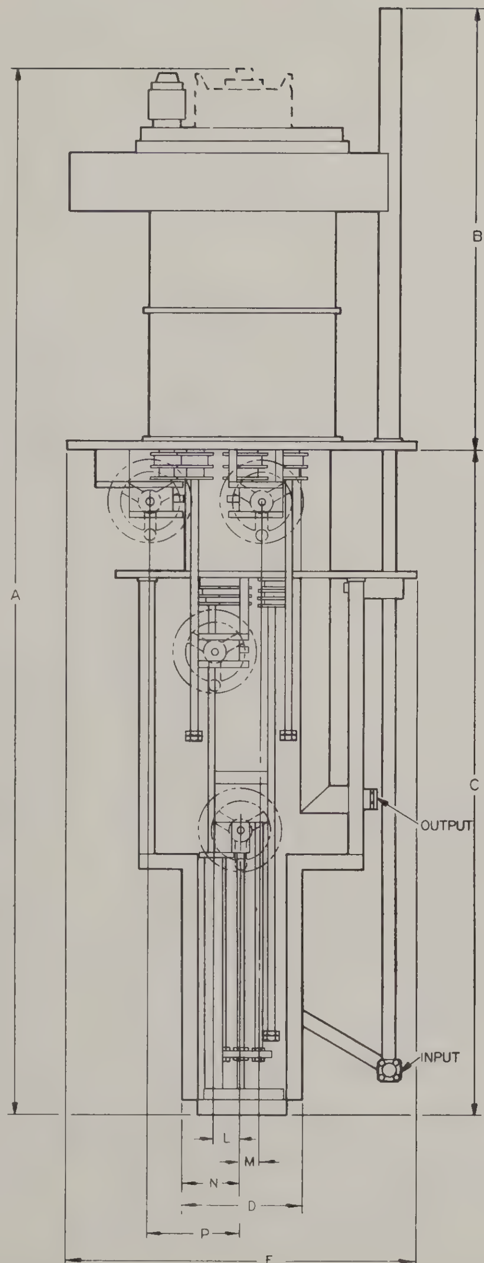
Mounting	Requires Special Cabinet
Size	Height - 72 inches Width - 28 inches Depth - 28 inches
Operating Controls	Tuning knobs provided
Cooling	Anode: 365 CFM at 3.5" water Filament: 40 CFM at 2.0" water
Connectors	Input - Type LC Female Output - 1-5/8" E1A Coax Flange

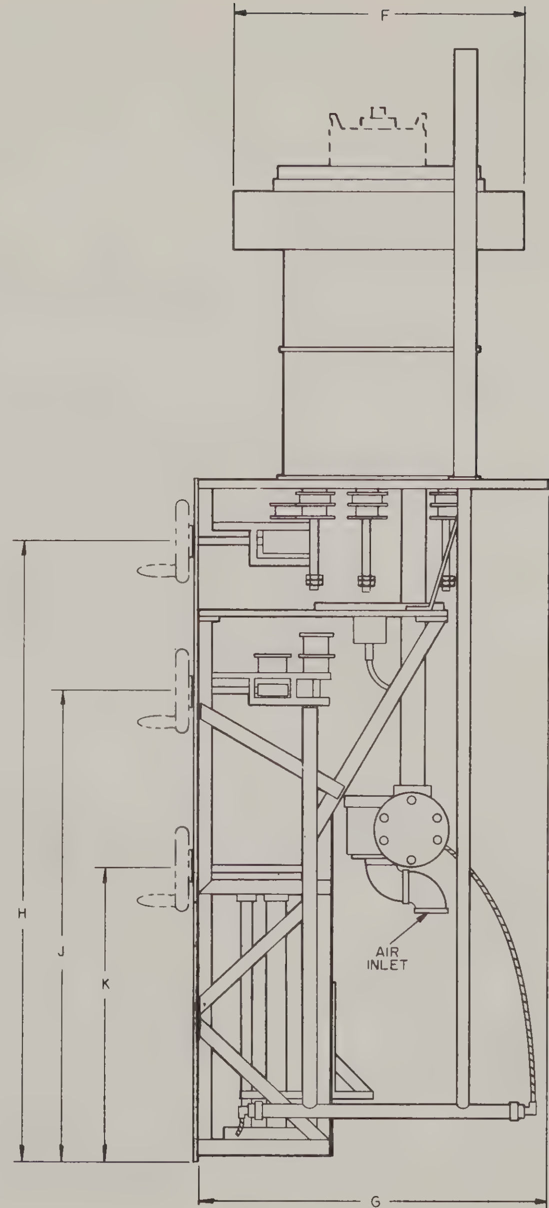
ENVIRONMENTAL

Temperature	-10 to +50°C (+14 to +122° F)
Altitude	to 12,000 feet

EM4507


NOTES:
ALL CAPACITOR VALUES ARE IN MICRO-MICRO FARADS UNLESS NOTED.
L1
C1 500
SPARK GAP
XV4
C6 10,000
V1
C5 10,000
XV3
W3
LC1
W2
XV2
XV1
STUB TWO
STUB ONE
J5
P4
C4 2000
C4
J3
P2
S1
J1
J2 P1
W1
P5
P3 J4
L2
C2 1000
C3 1000
Ebb +6KV
LS1
ADJ. END
W4
J6
J7
W5
P6
P7
LINE STRETCHER NOT MOUNTED ON CV107
REFERENCE SCHEMATIC ONLY
FILAMENT RETURN
FIL. 7V DC, 102A
INPUT





SIDE VIEW

DIMENSION DATA			
REF	MIN	MAX	NOM
A	71.718	71.782	
B	33.906	33.968	
C	44.968	45.032	
D	8.219	8.281	
E	25.082	25.218	
F	20.816	20.940	
G	25.218	25.282	
H			41"
J			30⅝
K			19⅝
L	1.859	1.891	
M	1.328	1.359	
N	4.109	4.141	
P	6.484	6.516	

Eimac®

EITEL-McCULLOUGH, INC.

EM4515

CAVITY OSCILLATOR

1650 - 1800 Mc

The Eimac EM4515 is an ultra-stable cavity oscillator designed for use in microwave transmitters where compactness and ruggedness is required. Excellent frequency stability over a wide temperature range is a major advantage of this oscillator. It incorporates the Eimac Y319 ceramic-metal planar triode (conduction-cooled version of 3CX100A5).

CHARACTERISTICS

ELECTRICAL

Frequency	1650 - 1800* Mc	
RF Power Output	2.5** Watts CW	
Frequency Stability	0.75% from -50° F to +150° F	
Power Supply Requirements:	Voltage	Current
Anode, Maximum	250 V	75 mA
Control Grid, Maximum	-	Self Bias
Heater	6.0 V	1 A
Tube Type	Eimac Y319	
Load Impedance	50 ohms nominal	
Modulation	CW	

MECHANICAL

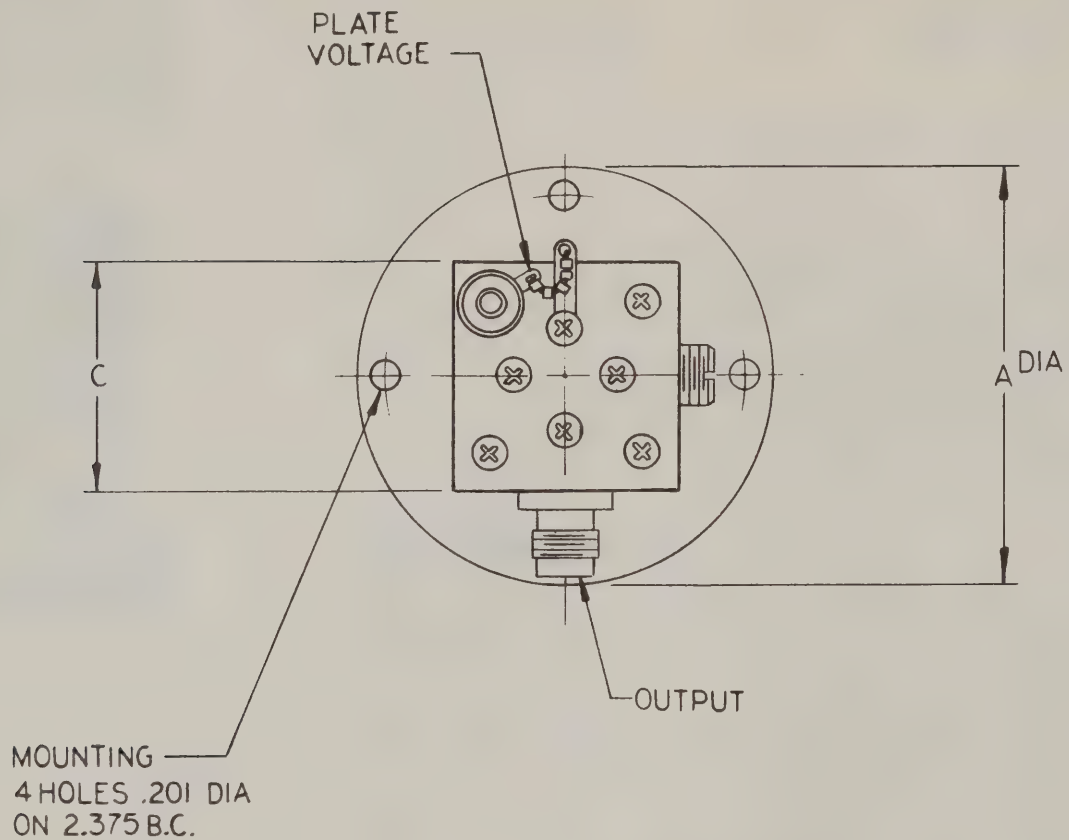
Mounting	has 2.75" diameter flange
Size	Height - 3.75 inches
	Width - 1.5 inches
	Depth - 1.5 inches
Weight	3 pounds
Cooling	Conduction
Connector	Type TNC Female

ENVIRONMENTAL

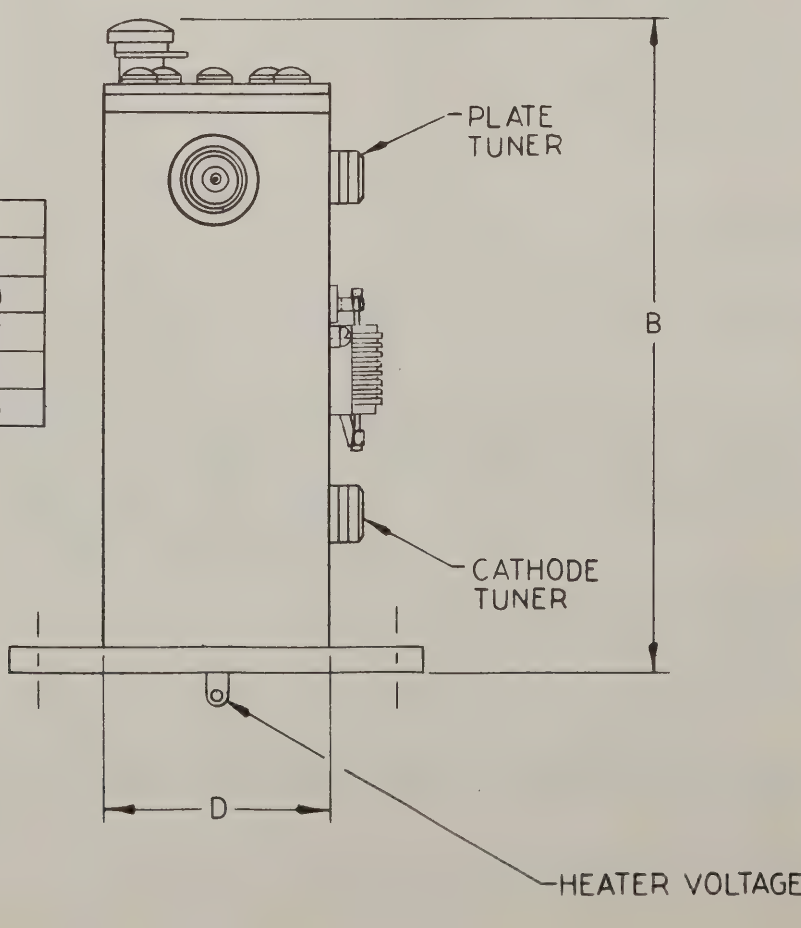
Temperature	-50° F to +150° F
Altitude	to 12,000 feet

*Factory adjusted for any 80 Mc Segment of the 1650 - 1800 Mc band.

**Can provide up to 20 watts output with higher anode voltage and current and special cooling.



DIMENSION DATA		
REF	MIN	MAX
A	2.740	2.760
B	3.741	3.857
C	1.484	1.516
D	1.484	1.516



EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

EM4516

CAVITY AMPLIFIER CHAIN

122-150 Mc

The Eimac EM4516 is a three stage amplifier chain designed for use as the driver amplifier section in FM transmitters. The first two stages are Eimac EM4505 cavity amplifiers incorporating the 4CX250R ruggedized tetrode. The final stage is Eimac cavity amplifier EM4506 which uses the 4CX1000K tetrode. The three stages are mounted on a panel which fits a standard 19" rack.

CHARACTERISTICS

ELECTRICAL

Frequency	122-150 Mc
RF Power Output	1 kW CW
RF Drive Power Required	1 Watt

Power Supply Requirements (Typical):

	Stage 1		Stage 2		Stage 3	
	Voltage	Current	Voltage	Current	Voltage	Current
Anode	400 V	150 mA	750 V	250 mA	3000 V	800 mA
Screen	100 to 200 V	−25 to +25 mA	150 to 250 V	−10 to +40 mA	250 to 350 V	−75 to +75 mA
Grid	−20 to −70 V	−10 mA	−50 to −100 V	−15 mA	−50 to −125 V	−10 mA
Heater/Filament	6.0 V	2.6 A	6.0 V	2.6 A	6.0 V	12.0 A

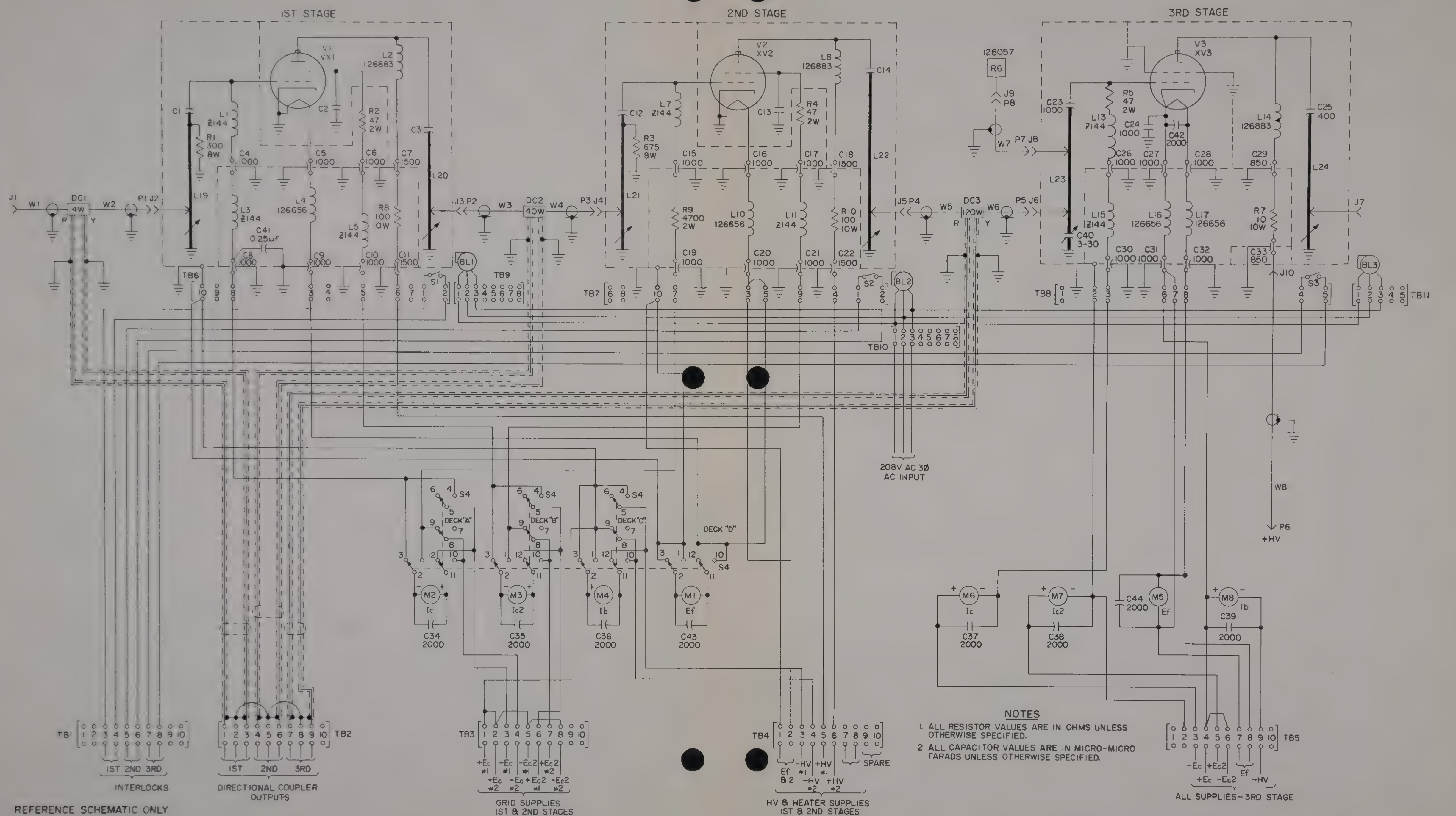
Tube Type	Eimac 4CX250R and 4CX1000K
Load Impedance	50 ohms
Bandwidth	2 Mc at 1.5 db
Modulation	FM-CW

MECHANICAL

Mounting	Standard 19" relay rack
Size	Height - 60 inches Depth - 28 inches
Cooling	Blowers provided
Connectors	Input - Type N Female Output - Type LC Female

ENVIRONMENTAL

Temperature	-10 to +50° C (+14 to +122° F)
Altitude	to 12,000 feet

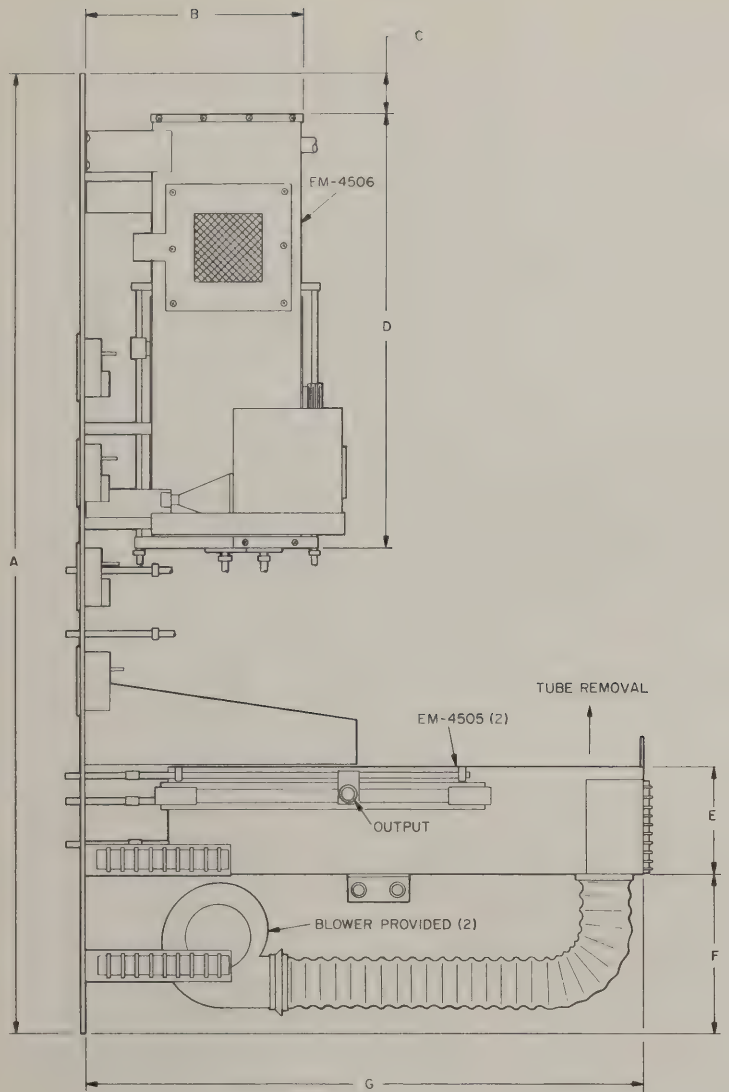


NOTES

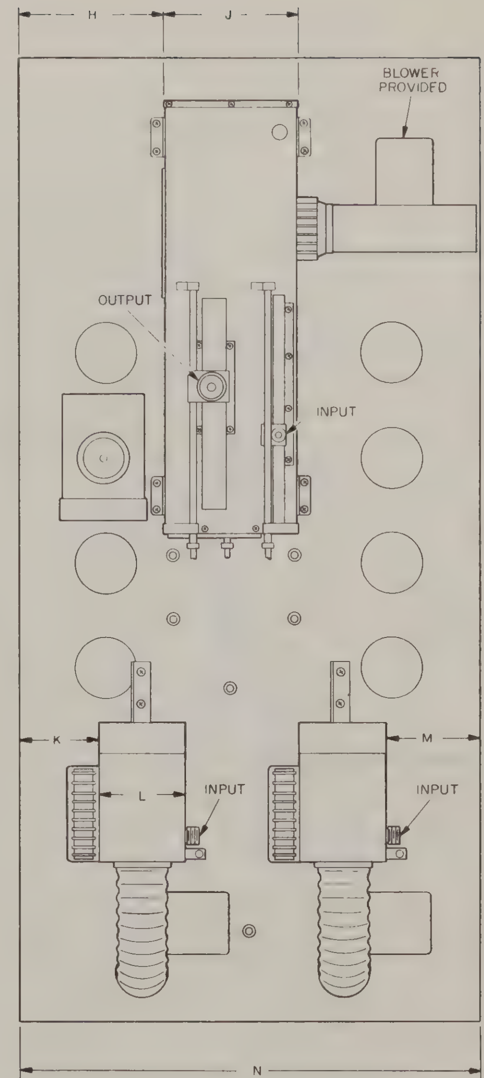
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES ARE IN MICRO-MICRO FARADS UNLESS OTHERWISE SPECIFIED.

REFERENCE SCHEMATIC ONLY

DIMENSION	DATA	
REF	MIN	MAX
A	45.940	46.060
B	10.484	10.516
C	1.922	1.954
D	20.530	20.594
E	5.109	5.141
F	7.734	7.766
G	25.938	26.062
H	6.812	6.876
J	6.234	6.266
K	4.406	4.470
L	4.109	4.141
M	3.906	3.960
N	21.940	22.060



SIDE VIEW



BACK VIEW

NOTE:
FOR CONTROL SHAFT LOCATING DIMENSIONS SEE INDIVIDUAL CAVITY AMPLIFIER SPEC SHEET.

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

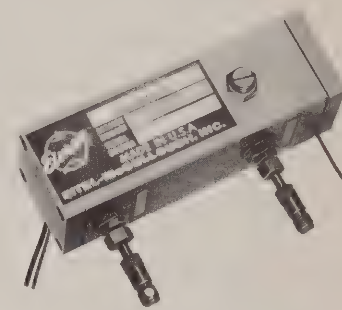
EM4523

CAVITY AMPLIFIER

2200-2300 Mc

20 WATTS CW

The Model EM4523 cavity amplifier is a compact modular amplifier readily adaptable to airborne or ground support telemetry and communications systems. The Model EM4523 is an optimum combination of the tube configuration with the associated RF circuit. Maximum efficiency and RF output from a very small package are outstanding features offered by this amplifier. Tuning can be accomplished with a minimum of test equipment.



CHARACTERISTICS

ELECTRICAL

Tuning Range		2200-2300 Mc
Tube Type		Eimac A126066
Power Supply Requirements:		
Anode Voltage	750	V
Current	100	mA
Heater Voltage	6.0	V
Current	1.0	A

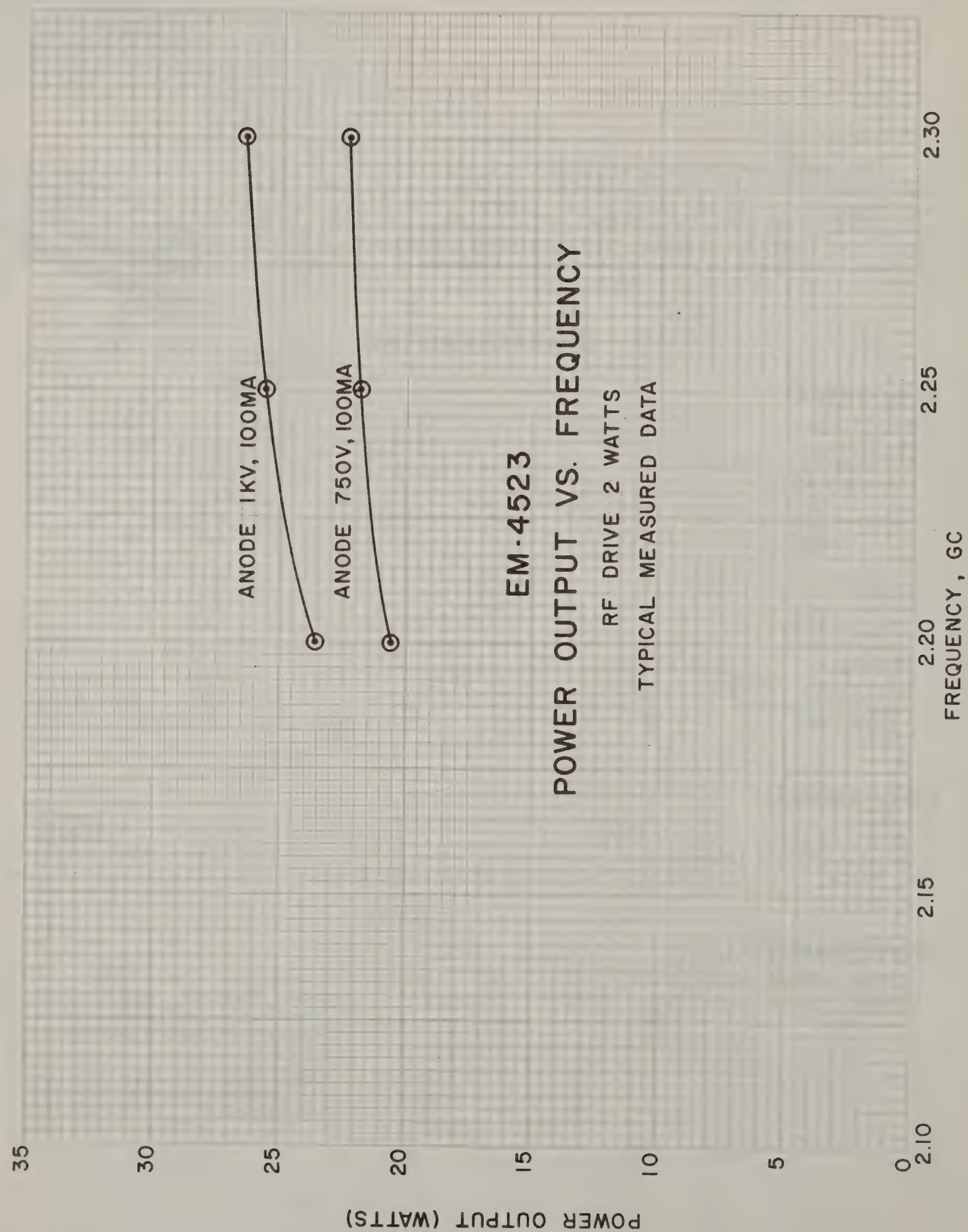
Operating Characteristics:		
Power Input	2.0	W
Power Output	20	W
Modulation		CW/FM
Bandwidth, 3 db points	10	Mc
Frequency Stability	20	PPM/°C
Load Impedance	50	ohms nominal
Load VSWR	1.5:1	Any Constant Phase

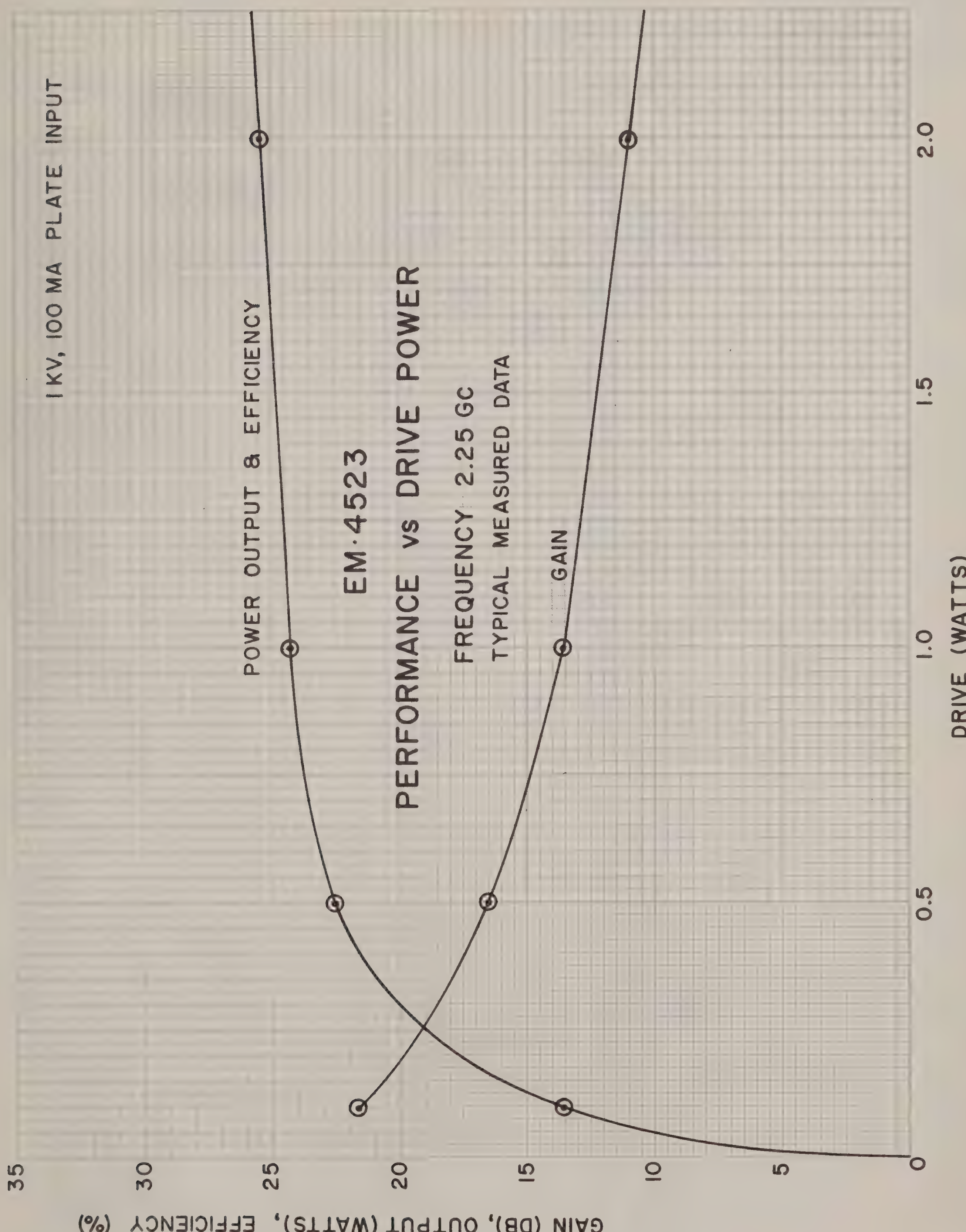
MECHANICAL

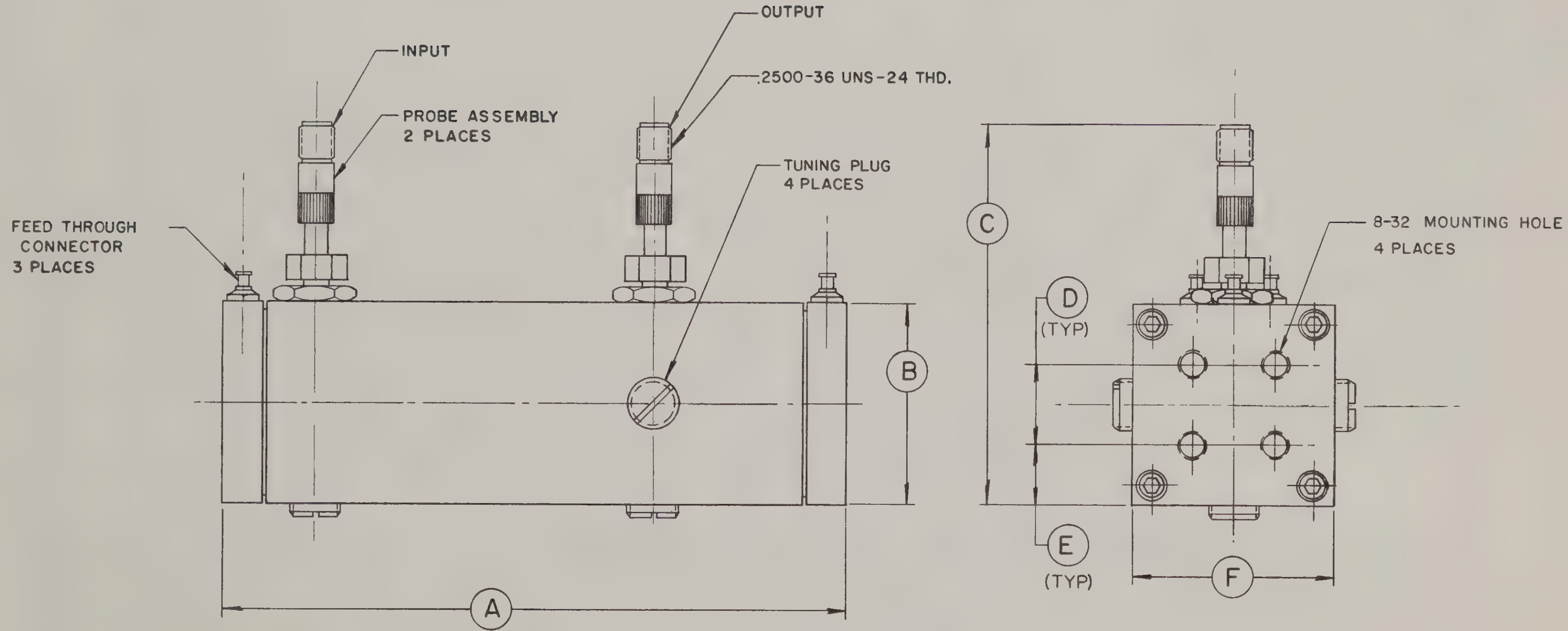
Connectors	Type BRM
Cooling	Conduction
Maximum Overall Dimensions	1.25"x1.25"x4.0"
Net Weight	0.85 pounds

ENVIRONMENTAL

Mounting Surface Temperature	—40 to +100°C
Vibration	Shall meet the requirements of Method 514, MIL-Standard-810, Class 1 through 4 and mounting Type A.
Shock	Shall meet the requirements of Procedure 1, Method 516 of MIL-Standard-810.


EM-4523
POWER OUTPUT VS. FREQUENCY
RF DRIVE 2 WATTS
TYPICAL MEASURED DATA
ANODE 1KV, 100MA
ANODE 750V, 100MA
POWER OUTPUT (WATTS)
0
5
10
15
20
25
30
35
FREQUENCY, GC
2.10
2.15
2.20
2.25
2.30


EM-4523
PERFORMANCE vs DRIVE POWER
FREQUENCY 2.25 GC
TYPICAL MEASURED DATA
1 KV, 100 MA PLATE INPUT
POWER OUTPUT & EFFICIENCY
GAIN
DRIVE (WATTS)
GAIN (DB), OUTPUT (WATTS), EFFICIENCY (%)
0
0.5
1.0
1.5
2.0
5
10
15
20
25
30
35



DIMENSION DATA		
REF	MIN	MAX
A	3.820	3.910
B	1.245	1.255
C	2.360	2.610
D	.495	.505
E	.370	.380
F	1.245	1.255

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TABLE OF CONTENTS

*Not recommended for New Equipment Design.

(Effective 2-29-64)

TETRODES—PENTODES (Continued)

	Effective Date
4CX3000A/8169	3-1-63
4CX5000A/8170	2-15-63
4CX5000R/8170W	1-1-63
4CX10,000D/8171	1-20-62
4CX15,000A/8281	10-10-62
4CX35,000C/8349	11-1-63
4W300B	6-16-60
4W20,000A/8173	2-1-62
4X150A & 4X150D	6-15-60
4X150G/8172	8-15-63
4X150R/8296 & 4X150S/8297	5-15-62
4X250B	1-1-60
4X500A	1-1-64
7580	3-31-61
4E27A/5-125B	8-15-52

POWER KLYSTRONS

3K2500LX	9-15-58
3K2500SG	4-22-58
3K3000LQ	6-6-58
3K50,000LA, F, Q	5-9-58
3KM3000LA	6-6-58
3KM4000LT	11-15-62
3KM50,000PA	7-15-60
4K3CB	10-16-62
4K50,000LQ	5-28-58
4KM50SK	5-2-63
4KM100LA	9-25-62
4KM3000LQ	9-1-60
4KM3000LR	10-1-60
4KM50,000LA3	10-20-61
4KM50,000LF	10-20-61
4KM50,000LQ	8-15-60
4KM50,000LR	10-20-61
4KM170,000LA	10-1-60
4KMP10,000LF	10-1-60
5K210,000LQ	10-20-61
X626AC	10-20-61

WATER LOAD

WL-150	11-1-63

REFLEX KLYSTRONS TWT — VTM

REFLEX KLYSTRONS

1K20XD	———
1K20XD-A	12-27-62
1K20XD-S	12-29-62
1K20XK	———
1K20XN-A	12-27-62
1K20XS	———
1K015CA, CG	2-16-60
1K75CH, CK	———
1K75CS	8-10-60
1K125CB	———
X1075	8-10-62
X1075-A	8-10-62
X1115A	3-5-63
X1115B	3-5-63
X1116A	3-5-63
X1116B	3-5-63
X1120	6-19-63
X1120-B	6-19-63
X1130	6-19-63
X1149	1-1-64

TWT

EM-778/8198	4-1-62
EM-779	4-1-62

TWT (Continued)

	Effective Date
EM-1006	4-1-62
EM-1010	4-1-62
EM-1011	4-1-62
EM-1015	4-1-62
EM-1016	4-1-62
X1021	8-1-62
EM-1025	4-1-62
EM-1030	4-1-62
EM-1031	4-1-62
EM-1045	4-1-62
EM-1046	4-1-62
EM-1050	4-1-62
EM-1051	4-1-62
EM-1060	4-1-62

VTM

EM-747	2-15-63
EM-1080	6-14-63
X1081	2-15-63
X1084	8-1-62
X1085	7-27-62
EM1086	10-27-62
X1091	10-27-62
X1092	3-5-63

OTHER PRODUCTS

HV-1 Diffusion Pump	11-1-60
VS-2, 4, 5, & 6	12-1-63
100 IG Ionization Gauge	6-15-53
Preformed Contact Finger Stock	1-15-62
HR Heat Dissipating Connectors	12-12-57
SK-300	1-1-63
SK-306, SK-316	5-21-63
SK-400	4-1-56
SK-406, SK-416	5-17-63
SK-410	11-15-62
SK-500	3-1-56
SK-506, SK-516	5-21-63
SK-510	5-4-63
SK-600	3-31-61
SK-600A	5-9-63
SK-606, SK-626, SK-636B	5-24-63
SK-610	3-31-61
SK-620, SK-620A	1-15-63
SK-630, SK-630A	1-18-63
SK-640	3-31-61
SK-650 and SK-655	3-31-61
SK-700, SK-710, SK-606	1-20-58
SK-711A	5-9-63
SK-740	5-9-63
SK-760, SK-770	5-9-63
SK-800A, SK-806	9-15-60
SK-810, SK-806	9-15-60
SK-860, SK-870	5-9-63
SK-890, SK-806	9-15-60
SK-900, SK-906	6-1-60
SK-1300	5-9-63
SK-1306, SK-1406	5-17-63
SK-1400A, SK-1470A	5-9-63

CAVITY AMPLIFIER

X4523	3-5-63
X4524	3-5-63
X4539	3-5-63
X4540	3-5-63
X4546	9-1-63

Eimac®

EITEL-McCULLOUGH, INC.

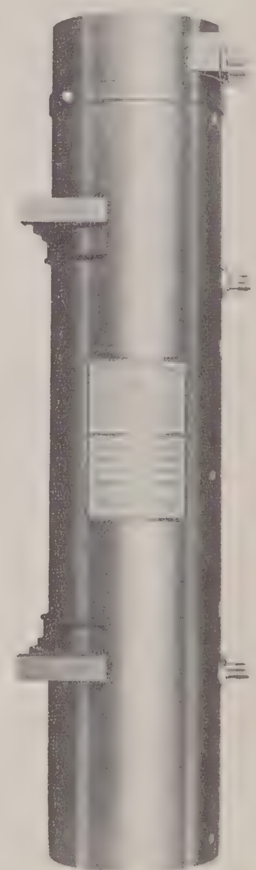
February, 1964

EIMAC and EIA TUBE NUMBER CROSS REFERENCE SHEET

EIMAC NO.	EIA NO.	EIA NO.	EIMAC NO.
3CPN10A5	7815	7034	4X150A
3CPX100A5	7815R	7035	4X150D
3CX100A5	7289	7203	4CX250B
3CX100F5	8250	7204	4CX250F
3CX1000A7	8238	7289	3CX100A5
3CX10, 000A1	8158	7580W	4CX250R
3CX10, 000A3	8159	7815	3CPN10A5
3CX10, 000A7	8160	7815R	3CPX100A5
3W5000A1	8240	8158	3CX10, 000A1
3W5000A3	8242	8159	3CX10, 000A3
3W5000F1	8241	8160	3CX10, 000A7
3W5000F3	8243	8161	3X2500A3
3X2500A3	8161	8162	3X3000F7
3X2500F3	8251	8163	3–400Z
3X3000A1	8238	8164	3–1000Z
3X3000F1	8239	8165	4–65A
3X3000F7	8162	8166	4–1000A
3–400Z	8163	8167	4CX300A
3–1000Z	8164	8168	4CX1000A
4–65A	8165	8169	4CX3000A
4–400A	8438	8170	4CX5000A
4–1000A	8166	8171	4CX10, 000D
4CV100, 000C	8351	8172	4X150G
4CW50, 000C	8350	8173	4W20, 000A
4CX250B	7203	8187	4PR65A
4CX250F	7204	8188	4PR400A
4CX250K	8245	8189	4PR1000A
4CX250M	8246	8238	3X3000A1
4CX250R	7580W	8239	3X3000F1
4CX300A	8167	8240	3W5000A1
4CX350A	8321	8241	3W5000F1
4CX350F	8322	8242	3W5000A3
4CX1000A	8168	8243	3W5000F3
4CX1000K	8352	8245	4CX250K
4CX3000A	8169	8246	4CX250M
4CX5000A	8170	8247	4PR125A
4CX10, 000D	8171	8248	4PR250C
4CX15, 000A	8281	8249	4W300B
4CX35, 000C	8349	8250	3CX100F5
4PR60B	8252	8251	3X2500F3
4PR65A	8187	8252	4PR60B
4PR125A	8247	8281	4CX15, 000A
4PR250C	8248	8283	3CX1000A7
4PR400A	8188	8296	4X150R
4PR1000A	8189	8297	4X150S
4W300B	8249	8321	4CX350A
4W20, 000A	8173	8322	4CX350F
4X150A	7034	8349	4CX35, 000C
4X150D	7035	8350	4CW50, 000C
4X150G	8172	8351	4CV100, 000C
4X150R	8296	8352	4CX1000K
4X150S	8297	8438	4–400A

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 113
TRAVELING WAVE TUBE



The EM113 delivers 1 kw of pulse power from 2.0–4.0 Gc. It is of metal-ceramic construction and is suitable for airborne and missile applications. The focusing is accomplished by periodic permanent magnet and compensated for operation over the temperature range —65° C to +125° C.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Pulse Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Duty Cycle	2%

Operating and Performance Data

Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7500 Vdc
Peak Cathode Current	1.3 adc
Duty Cycle	2%
Frequency Range	2.0–4.0 Gc
Small Signal Gain—Minimum	36 db
Peak Saturated Power Out—Minimum	1.0 kw
Saturated Gain—Minimum	30 db

ENVIRONMENTAL SPECIFICATIONS

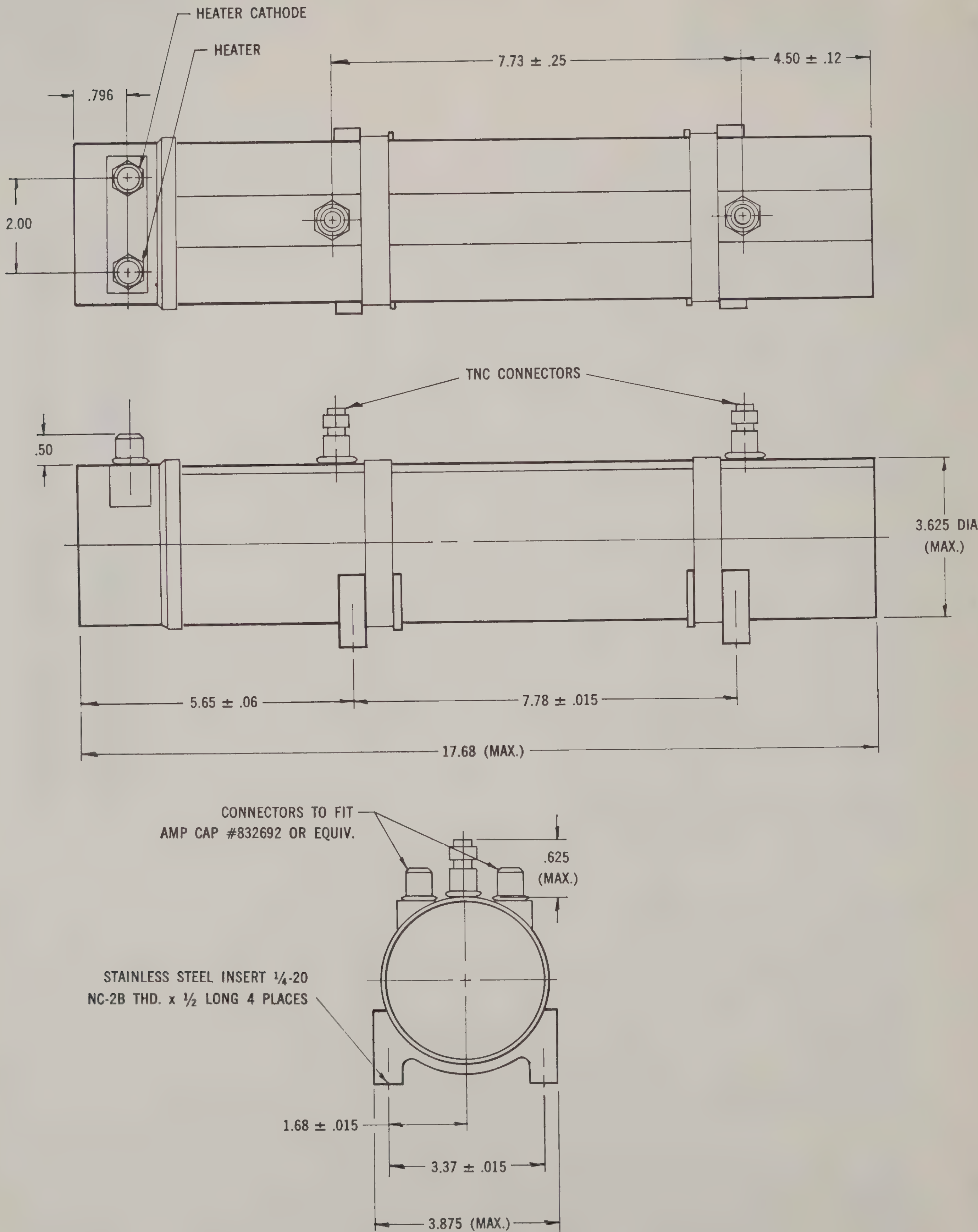
Complies with MIL-5400 Class II Equipment

Temperature	−65° C to +125° C

MECHANICAL SPECIFICATIONS

Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

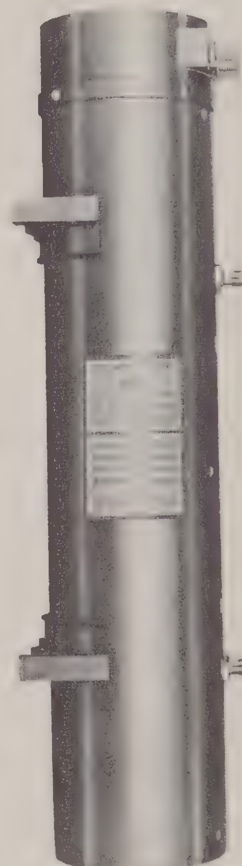
NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.


HEATER CATHODE
HEATER
.796
7.73 ± .25
4.50 ± .12
2.00
TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)
CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT 1/4-20
NC-2B THD. x 1/2 LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 114
TRAVELING WAVE TUBE



The EM114 is a grid modulated pulse TWT covering the frequency range of 2.8–3.5 Gc with a peak power output of 2.0 kw. This tube is designed for use in airborne and missile environments.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Cathode Voltage	–8000 vdc
Peak Cathode Current	2.0 adc
Grid Voltage	+400 to –150 vdc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	–7800 Vdc
Peak Cathode Current	1.5 adc
Grid Voltage (Beam on)	200 Vdc
Grid Voltage (Beam off)	–90 Vdc
Duty Cycle	2%
Frequency Range	2.8–3.5 Gc
Small Signal Gain—Minimum	36 db
Saturated Power Out—Minimum	2.0 kw
Saturated Gain—Minimum	30 db
Grid Capacitance (to all other elements)	15 picofds.

ENVIRONMENTAL SPECIFICATIONS

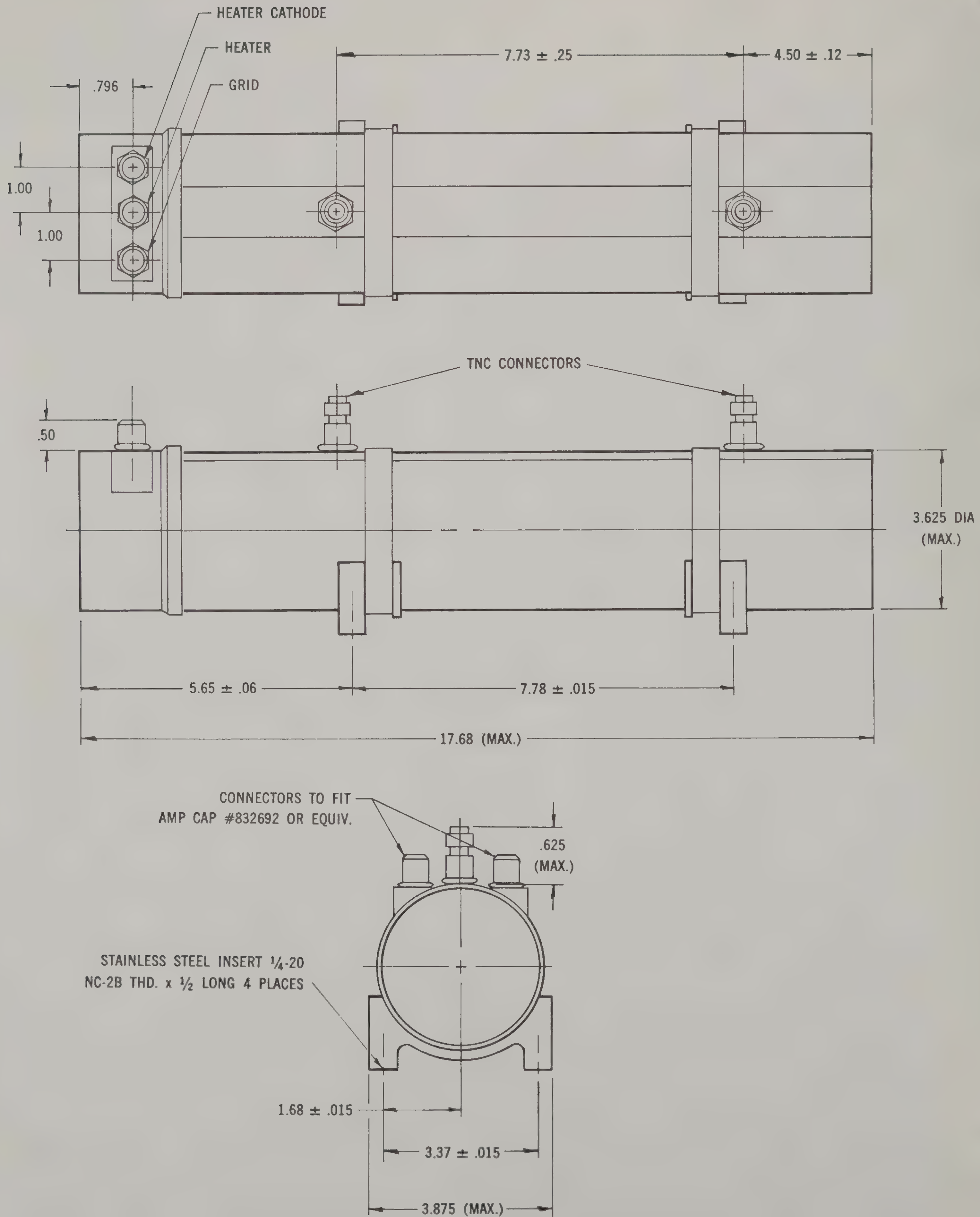
Complies with MIL-5400 Class II Equipment

Temperature	–65°C to +125°C

MECHANICAL SPECIFICATIONS

Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

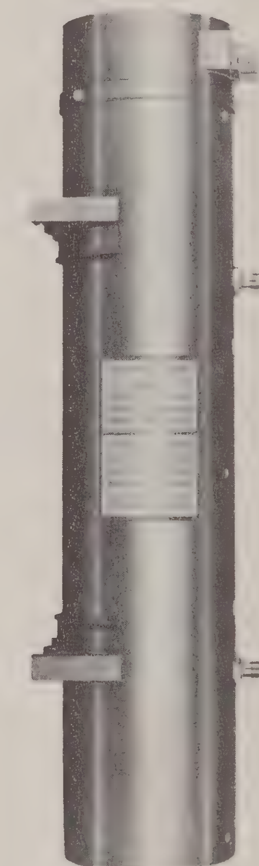

HEATER CATHODE
HEATER
GRID
.796
1.00
1.00
7.73 ± .25
4.50 ± .12
TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)
CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT 1/4-20
NC-2B THD. x 1/2 LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 116

TRAVELING WAVE TUBE

The EM116 is a 2% duty cycle TWT providing 1.6 kw of power over the frequency range of 2.9–3.1 Gc. This tube is PPM focused and of metal-ceramic construction for use in stringent environments.



ELECTRICAL SPECIFICATIONS

Absolute Ratings

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Pulse Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Duty Cycle	2%

Operating and Performance Data

Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7500 Vdc
Peak Cathode Current	1.3 adc
Duty Cycle	2%
Frequency Range	2.9–3.1 Gc
Small Signal Gain—Minimum	36 db
Saturated Power Out—Minimum	1.6 kw
Saturated Gain—Minimum	30 db

ENVIRONMENTAL SPECIFICATIONS

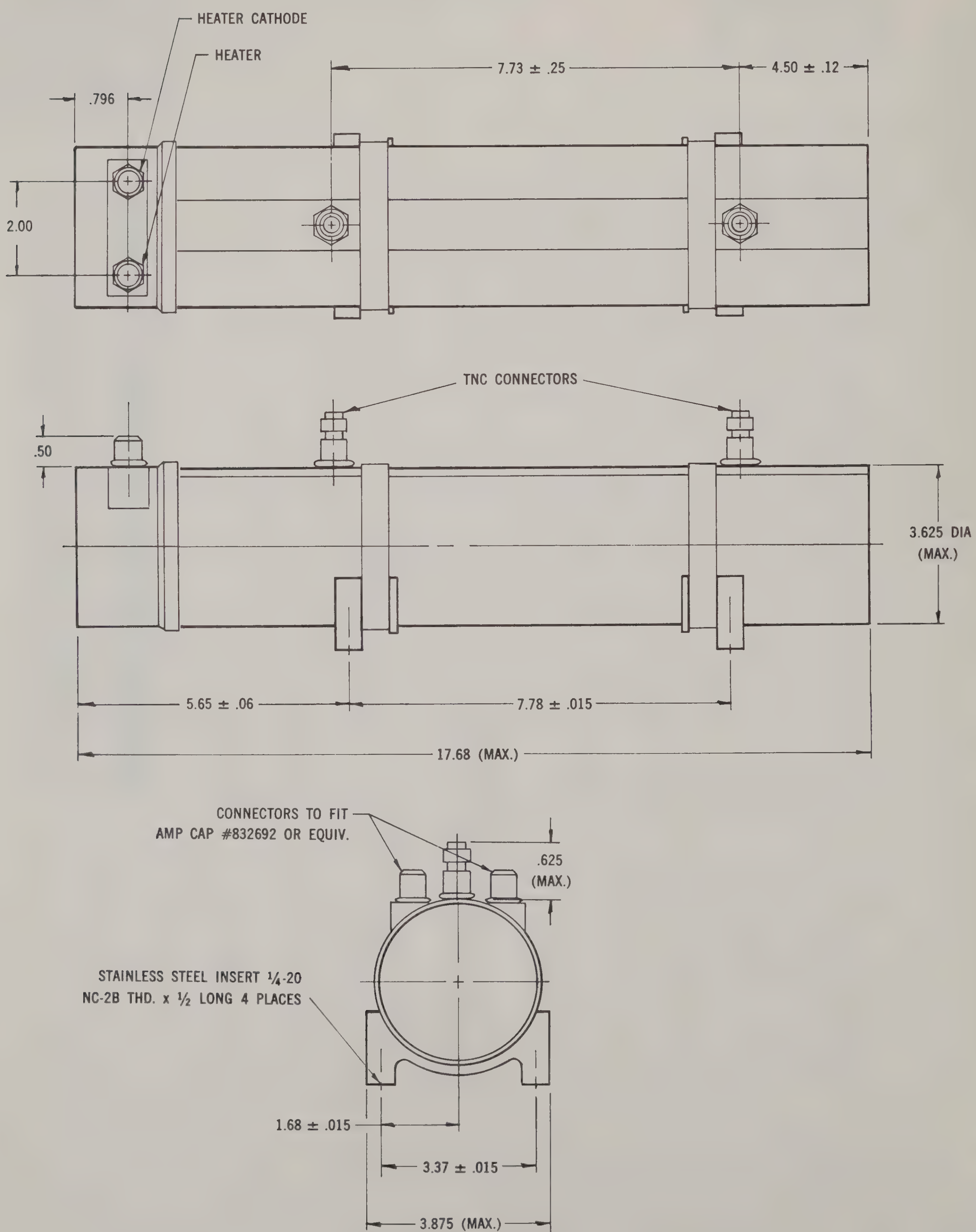
Complies with MIL-5400 Class II Equipment

Temperature	−65°C to +125°C

MECHANICAL SPECIFICATIONS

Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

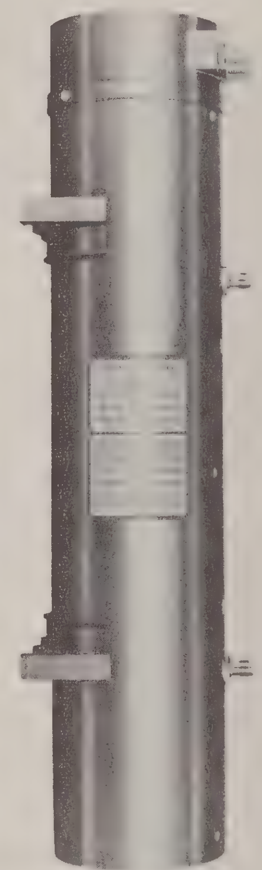
NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.


HEATER CATHODE
HEATER
.796
2.00
7.73 ± .25
4.50 ± .12
TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)
CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT 1/4-20
NC-2B THD. x 1/2 LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 118

TRAVELING WAVE TUBE



The EM118 is a medium-power grid pulse TWT suitable for operation in extreme environments. Rated power output of 500 watts is obtained over the frequency range of 2.7–2.9 Gc.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Cathode Voltage	−5000 Vdc
Peak Cathode Current	1.0 adc
Pulse Grid Voltage	+400, to −150 vdc
Duty Cycle	2%

Operating and Performance Data

Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−4700 Vdc
Peak Cathode Current	0.8 adc
Pulse Grid Voltage (Beam on)	+200 Vdc
Pulse Grid Voltage (Beam off)	−90 Vdc
Duty Cycle	2%
Frequency Range	2.7–2.9 Gc
Small Signal Gain—Minimum	46 db
Peak Saturated Power Out—Minimum	500 w
Saturated Gain—Minimum	40 db
Grid Capacitance (to all other elements)	15 picofds.

ENVIRONMENTAL SPECIFICATIONS

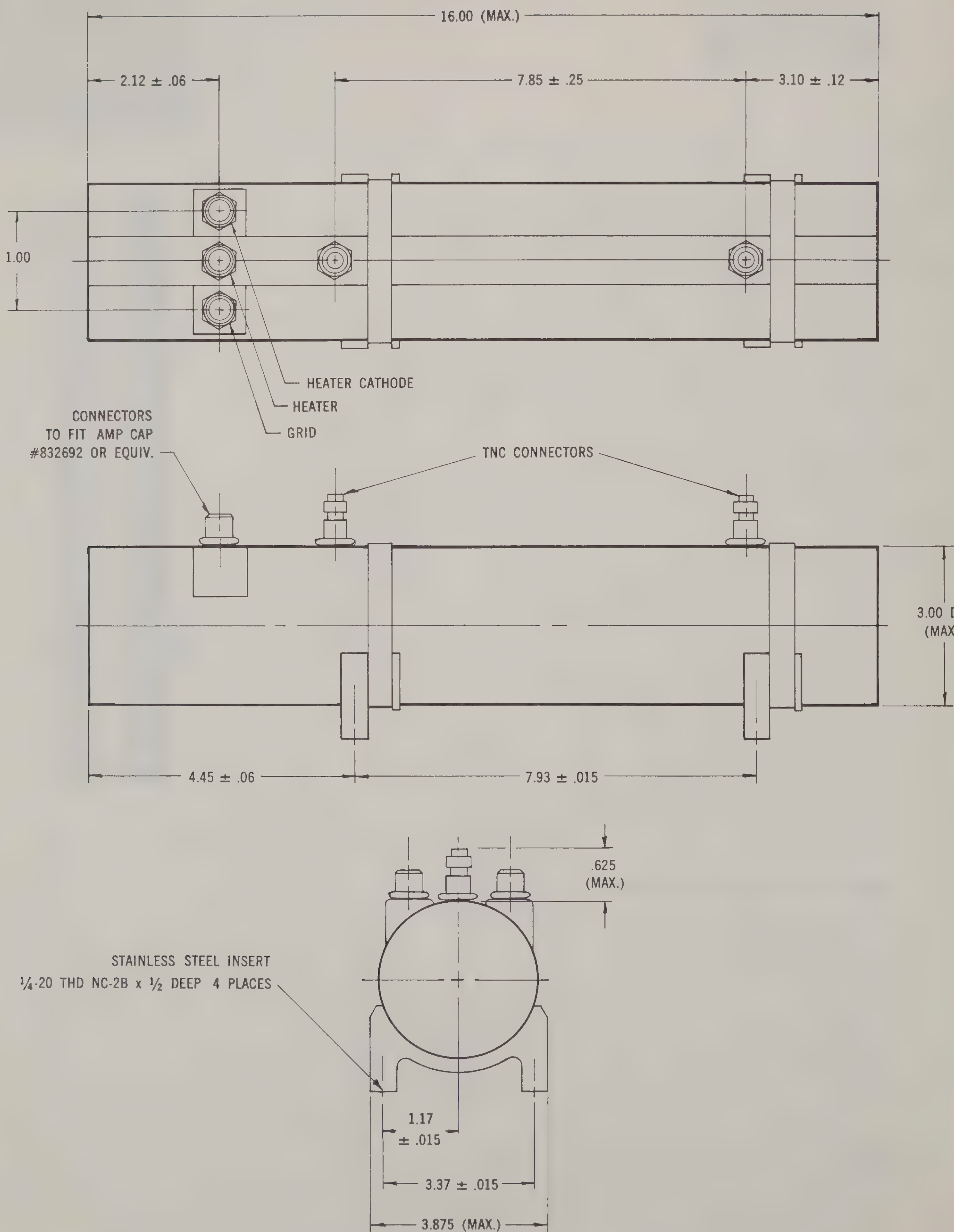
Complies with MIL-5400 Class II Equipment

Temperature	−65°C to +125°C

MECHANICAL SPECIFICATIONS

Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.


16.00 (MAX.)
2.12 ± .06
7.85 ± .25
3.10 ± .12
1.00
HEATER CATHODE
HEATER
GRID
CONNECTORS
TO FIT AMP CAP
#832692 OR EQUIV.
TNC CONNECTORS
3.00 DIA
(MAX.)
4.45 ± .06
7.93 ± .015
.625
(MAX.)
STAINLESS STEEL INSERT
¼-20 THD NC-2B x ½ DEEP 4 PLACES
1.17
± .015
3.37 ± .015
3.875 (MAX.)

Eimac®

EITEL-McCULLOUGH, INC.

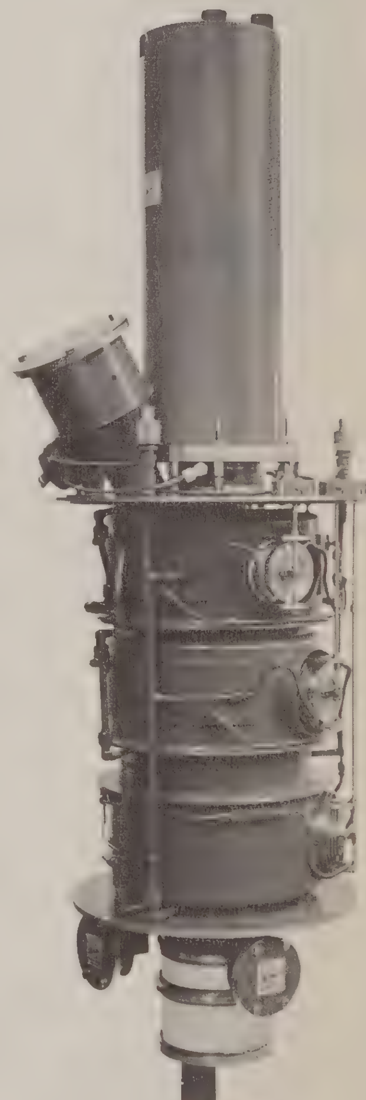
TENTATIVE DATA

3KM300LA

100 KW CW

345-455 Mc

POWER AMPLIFIER KLYSTRON



The Eimac 3KM300LA power-amplifier klystron is intended for use in tropospheric scatter communications systems requiring single spans up to 600 miles in length. This klystron delivers 100 kW CW output power from 345 to 455 megacycles with a power gain of 13 decibels.

Three integral resonant cavities are used in the 3KM300LA. Both input and output couplings are fixed and an additional coupling is provided for input cavity loading.

The electron gun of this tube has a confined flow configuration which minimizes focusing adjustments and provides a quiet, stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting rf output, body current, or other performance characteristics.

The 3KM300LA incorporates a titanium getter which should be energized whenever heater power is applied. Also included is a getter ion pump which provides means for monitoring the condition of the vacuum during operation.

A focusing electromagnet and klystron supporting structure, Catalog Number H-172, is provided for use with the 3KM300LA.

Eimac Water Load WL-160 is recommended for use with this klystron.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	26	volts
	Current	11.5	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	Voltage	4	volts
	Current	25	amperes
Power Gain		13	decibels
Output Power		100	kilowatts
Frequency Range		345 to 455	megacycles
Phase shift as a function of beam voltage		0.01	degrees/volt

MECHANICAL

Operating Position	Axis vertical, collector up
Coupling:	
Input	3-1/8 inch, 50-ohm coaxial
Input Cavity Loading	3-1/8 inch, 50-ohm coaxial
Output	6-1/8 inch, 50-ohm coaxial

MECHANICAL (cont'd)

Weight (3KM300LA)	560	pounds
Weight (H-172)	642	pounds
Length (3KM300LA)	73	inches
Diameter (3KM300LA)	22	inches
Length (H-172)	31	inches
Diameter (H-172)	28	inches

Cooling: Water and Forced Air*

	Flow Rate	Pressure Drop
Cathode	25 cfm	free
Body	5 gpm	40 psi
Collector	65 gpm	20 psi
Electromagnet	2 gpm	20 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Each of five coils	0 to 35 volts 0 to 20 amperes

MAXIMUM RATINGS

BEAM VOLTAGE	30	KILOVOLTS
BEAM CURRENT	9	AMPERES
BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	270	KILOWATTS
OUTLET COOLANT TEMPERATURE	70°	C
INPUT VSWR AT Fo	1.2:1	
INPUT VSWR AT ±0.5 Mc	1.3:1	
OUTPUT LOAD VSWR	1.2:1	

TYPICAL OPERATION, BROADBAND, CW AMPLIFIER**

Frequency	400	megacycles
Output Power	105	kilowatts
Driving Power	5	kilowatts
Power Gain	13.2	decibels
Beam Voltage	30	kilovolts
Beam Current	9	amperes
Modulating Anode Voltage (with respect to cathode)	27.8	kilovolts
Efficiency	39	percent
Body Current	50	milliamperes
Half-Power Bandwidth	2.0	megacycles
Input Cavity Loading	3.25	kilowatts

Electromagnet Currents:

Coil #1	15	amperes
Coil #2	10	amperes
Coil #3	10	amperes
Coil #4	10	amperes
Coil #5	10	amperes

*These requirements are for operation at sea level and maximum ambient air temperature of 30° C. Maximum inlet water temperature is 30° C. At higher altitudes or higher temperatures, additional cooling may be required.

**This data was obtained from the prototype and does not necessarily represent typical characteristics of production klystrons.

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.

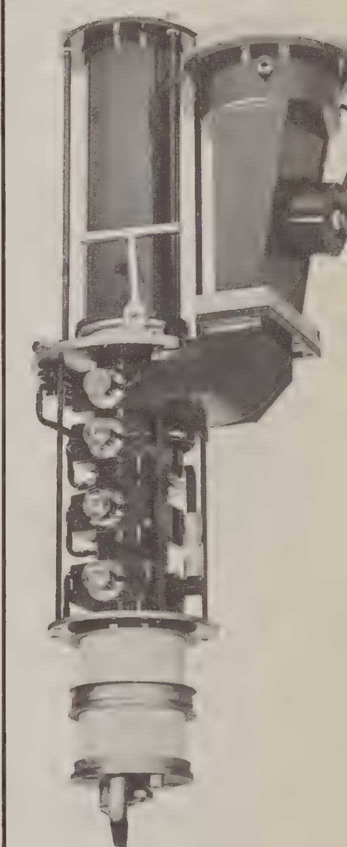
Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM70SJ

POWER AMPLIFIER S-BAND KLYSTRON



The Eimac 4KM70SJ is a power-amplifier klystron designed to operate at frequencies from 1700 to 2400 megacycles with a rated output power of 20 kilowatts and a minimum gain of 40 decibels. This klystron was the first product of Eimac's High Power Microwave Tube Laboratory, established in 1961. The design of the 4KM70SJ is completely new, incorporating many recent advances in klystron technology.

A large Eimac Matrix Type A cathode is used in the 4KM70SJ with cathode current loading of only 230 milliamperes per square centimeter. This light cathode loading assures long life. The electron gun has a confined flow configuration which minimizes focusing adjustments and produces a very stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting RF output or body current. Only one electromagnet power supply is required.

Four integral cavities are used in the 4KM70SJ. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc.

The 4KM70SJ incorporates a built-in vacuum pump, in the form of a titanium getter, which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the Eimac Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-136, has been designed for use with the 4KM70SJ.

Eimac Water Load WL-201 is recommended for use with this klystron.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7	volts
	Current	12	amperes
	Maximum Starting Current	24	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	AC Voltage (Nominal)	4	volts
	AC Current	20	amperes
	Power Gain	40	decibels
	Output Power	20	kilowatts
	Frequency Range	1700 to 2400	megacycles

MECHANICAL

Operating Position		Any
RF Coupling:	Input	Type N coaxial fitting
	Output	UG435A/U flange
Weight:	Klystron Only	90 lbs.
	H-136 Electromagnet	170 lbs.

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	20 cfm	free
Klystron Body	1.5 gpm	60 psi
Klystron Collector	18 gpm	40 psi
Electromagnet	1.5 gpm	25 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage	200	volts
Current	20	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	21	KILOVOLTS
DC BEAM CURRENT	4	AMPERES
DC BEAM INPUT POWER	70	KILOWATTS
DC BODY CURRENT	85	MILLIAMPERES
COLLECTOR DISSIPATION	70	KILOWATTS
INLET WATER PRESSURE	80	PSI
LOAD VSWR	1.5:1	

TYPICAL OPERATION

Frequency	2000	megacycles
Output Power	22.2	kilowatts
Driving Power	1	watt
Power Gain	43.5	decibels
DC Beam Voltage	20	kilovolts
DC Beam Current	2.8	amperes
DC Modulating-Anode Voltage	13	kilovolts
Beam Power Efficiency	40	percent
DC Body Current	60	milliamperes
3 db bandwidth	10	megacycles
Electromagnet Current	15	amperes

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

5KM70SF

POWER AMPLIFIER S-BAND KLYSTRON

The Eimac 5KM70SF is a power-amplifier klystron intended primarily for use in the ground transmitters of satellite communications systems. It is designed to operate at frequencies from 1710 to 1800 megacycles with an output power of 20 kilowatts when adjusted for maximum efficiency and an output power of 10 kilowatts as a wide-band linear amplifier.

In order to meet the exacting requirements of satellite communications systems the 5KM70SF must be capable of extraordinary performance as regards linearity, bandwidth, differential envelope time delay, incidental phase modulation, random amplitude modulated noise and ability to withstand environmental extremes.

A large Eimac Matrix Type A cathode is used in the 5KM70SF with cathode loading of only 300 milliamperes per square centimeter. This light cathode loading, for an S-band klystron, assures long life. The electron gun has a confined flow configuration which minimizes focusing adjustments and produces a stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting RF output or body current. Only one electromagnet power supply is required.

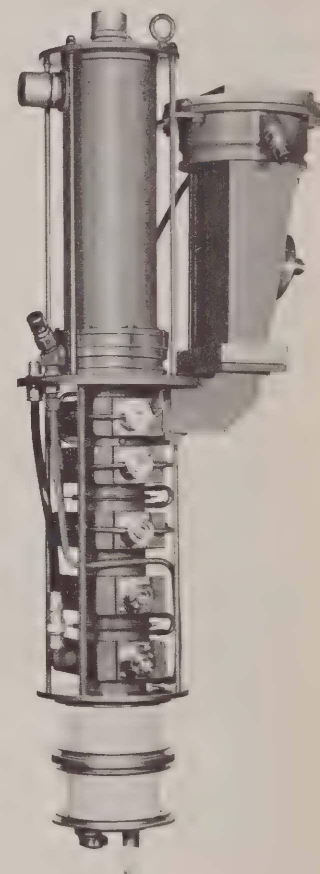
Five integral cavities are used in the 5KM70SF. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc which will withstand severe abuse. An arc detector is provided to protect this window.

A coupling loop is provided in the second cavity for use with an external load. This load should be capable of dissipating 20 watts minimum and must be connected whenever the tube is energized.

The 5KM70SF incorporates a built-in vacuum pump, in the form of a titanium getter, which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the Eimac Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-159, has been designed for use with the 5KM70SF.

Eimac Water Load WL-202 is recommended for use with this klystron.



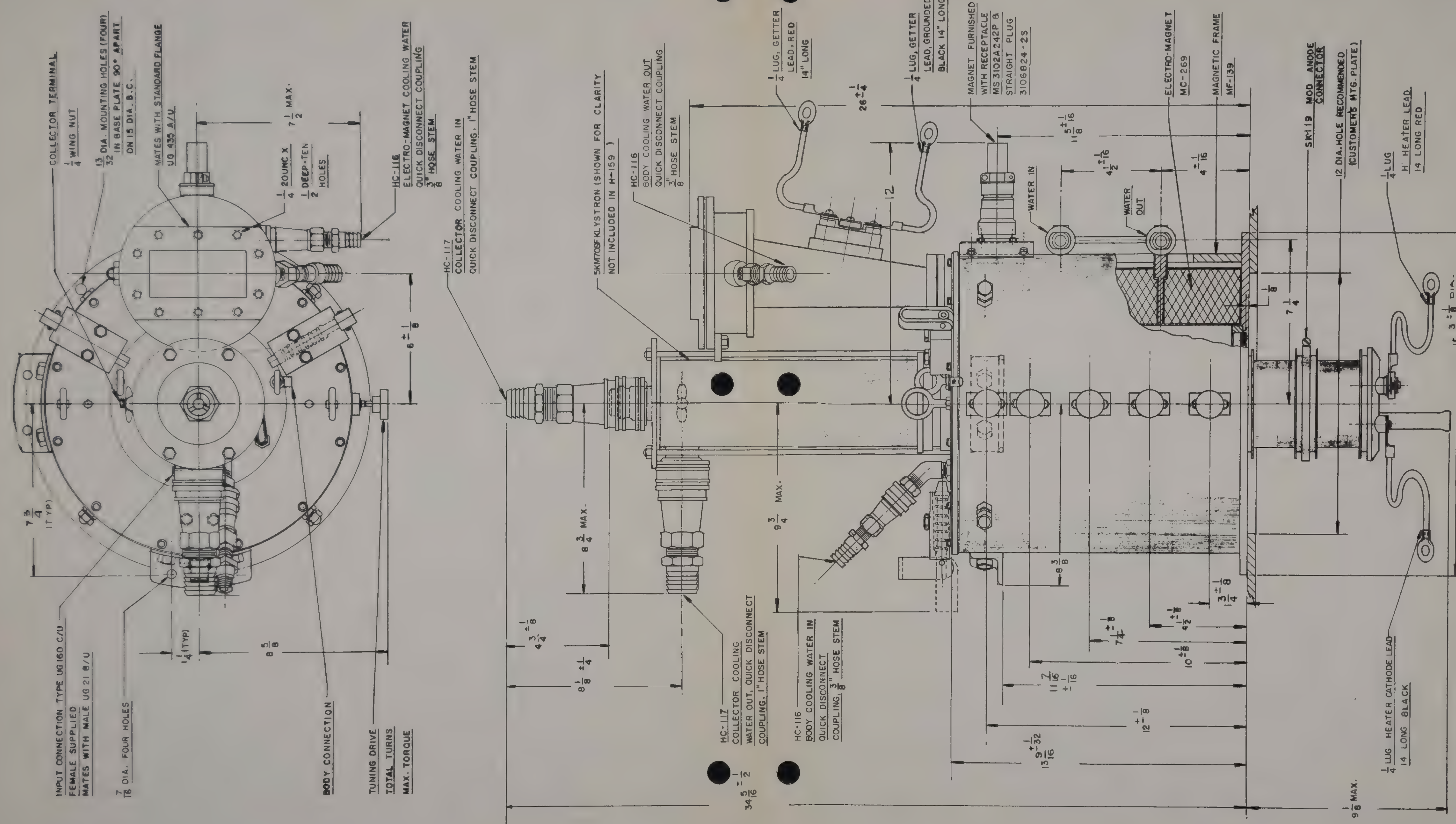
CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7.5	volts
	Current	12.5	amperes
	Maximum Starting Current	24	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	A-C Voltage (Nominal)	4	volts
	A-C Current	24	amperes
Power Gain		40	decibels
Output Power (Saturation drive)		20	kilowatts
Frequency Range		1710 to 1800	megacycles

5KM70SF Eimac

5KM70SF KLYSTRON AND H-159 CIRCUIT ASSEMBLY



MECHANICAL

Operating Position		Any
RF Coupling:		
	Input	Type N coaxial fitting
	Output	UG435A/U Flange
Weight:		
	Klystron Only	95 lbs.
	H-159 Electromagnet	205 lbs.
Cooling:	Water and Forced Air	

	Flow Rate	Pressure Drop
Cathode	20 cfm	free
Klystron Body	1.5 gpm	60 psi
Klystron Collector	20 gpm	40 psi
Electromagnet	2 gpm	25 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage	175	volts
Current	20	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	21	KILOVOLTS
DC BEAM CURRENT	5	AMPERES
DC BEAM INPUT POWER	70	KILOWATTS
DC BODY CURRENT	120	MILLIAMPERES
COLLECTOR DISSIPATION	70	KILOWATTS
INLET WATER PRESSURE	80	PSI
LOAD VSWR	1.5:1	

TYPICAL OPERATION

	Tuned for Maximum Efficiency	Tuned for Maximum Bandwidth	
Frequency	1725	1725	megacycles
Output Power	20	10.5	kilowatts
Driving Power	2	1	watts
Power Gain	40	40.2	decibels
DC Beam Voltage	18	17	kilovolts
DC Beam Current	3.85	3.7	amperes
DC Modulating-Anode Voltage	18	17	kilovolts
DC Body Current	90	80	milliamperes
1 db bandwidth	10	14	megacycles
Second Cavity Load	2	1	watts
Electromagnet Current	19	17.5	amperes

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

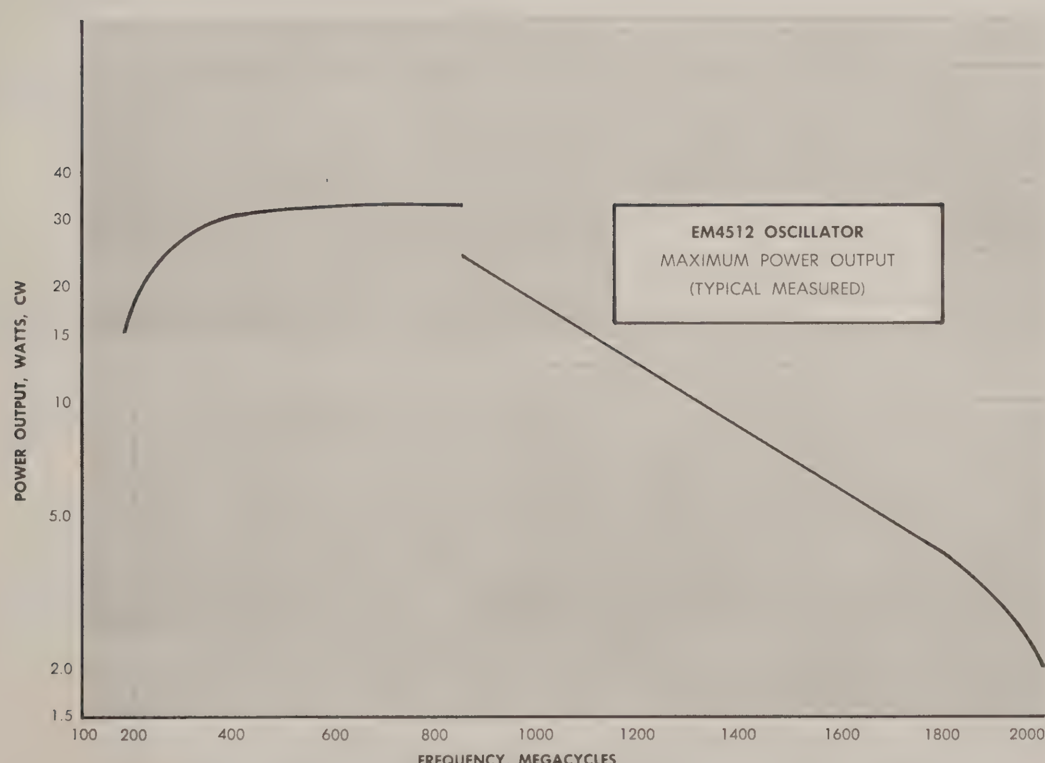
Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

EM 4512

BROAD TUNING OSCILLATOR 170-2000 Mc

The Eimac EM4512 is a broad-tuning cavity power oscillator incorporating the Eimac Y-319 ceramic-metal planar triode. It is intended for use in test equipment consoles and special transmitters. This oscillator has front-panel tuning knobs and frequency scales for tuning across the 170-2000 Mc band with power output from 25 to 2 watts.



CHARACTERISTICS

ELECTRICAL

Frequency, continuously tunable - - - - 170-2000 Mc

RF Power Output - - - -

Frequency, Mc	Power output, watts, CW
170- 300	15
300- 800	25
800-1200	10
1200-1600	5
1600-2000	2

Frequency Drift,(1) percent of operating frequency - - - - ±0.05%

Power Supply Requirements:

	Voltage	Current
Anode, maximum	1 KV	100 mA
Grid	Bias through variable cathode resistor, 200-1000 ohms	
Heater	6.0 V	1 A
Ground	Positive terminal of anode supply	

Cathode Current - - - - 125 mA
Tube Type - - - - Eimac Y-319
Load Impedance - - - - 50 ohms nominal
Load VSWR, maximum - - - - 2.0:1 any phase, without damage

MECHANICAL

Mounting - - - - Standard 19" relay rack
Size - - - - height--8-3/4 inches
depth--4-1/2 inches
Weight - - - - 10 pounds
Operating controls - - - - Tuning knobs and frequency scales provided(2)
Cooling - - - - Conduction--Convection(3)
Connector - - - - Type TNC Female

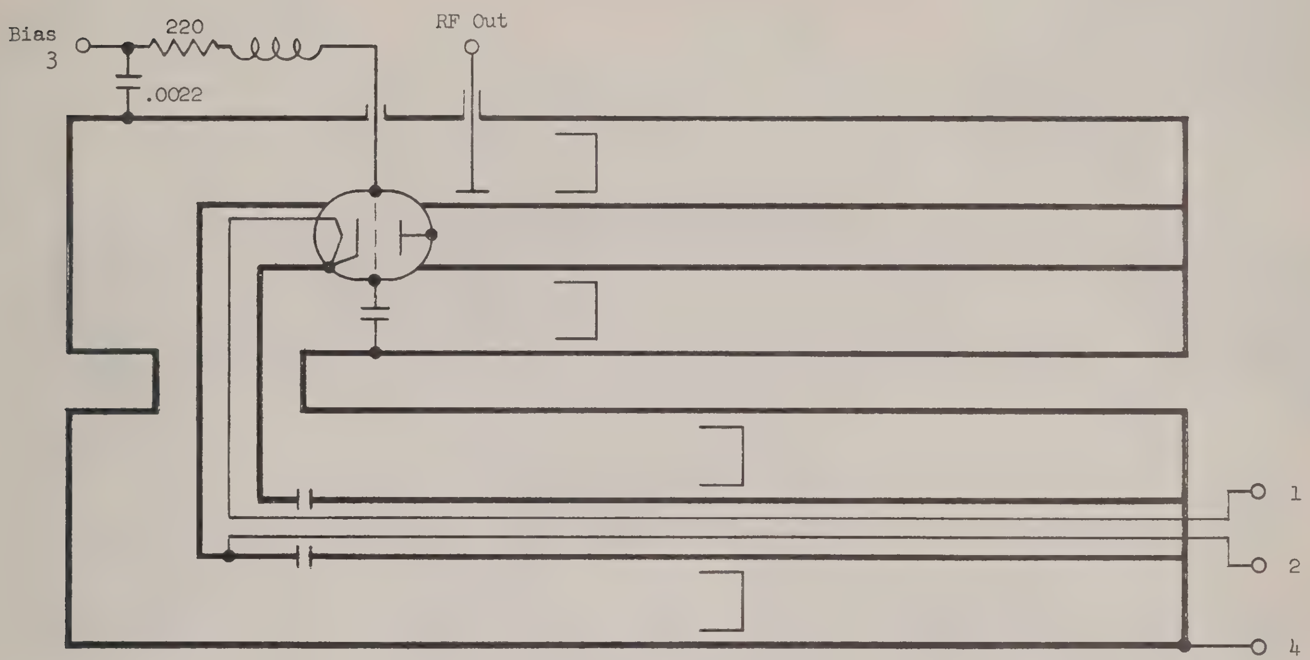
ENVIRONMENTAL

Temperature - - - - -10 to +50° C (+14 to +122° F)(3)
Altitude - - - - to 12,000 feet

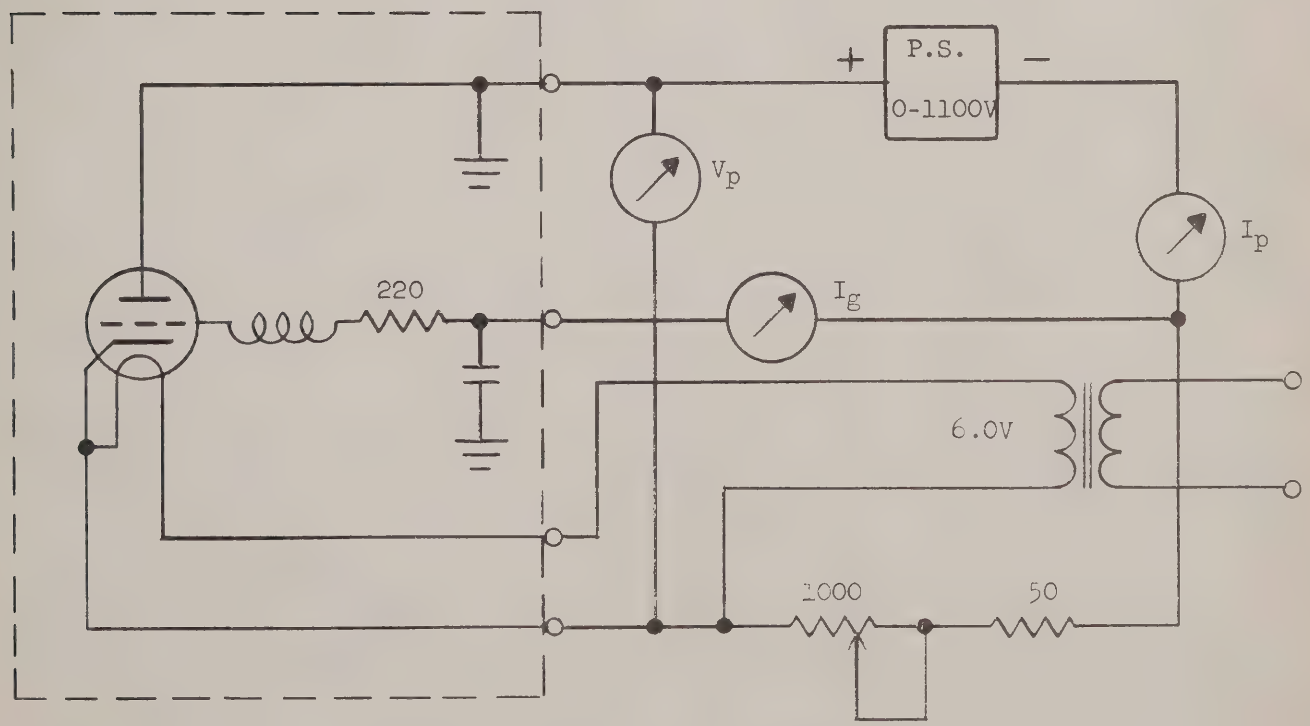
NOTES:

(1) Frequency drift is specified over a period of 2 hours, following a warm-up period of 1/2 hour minimum.
(2) Knobs are provided on the front panel for fine tuning the plate cavity and for adjusting output coupling. Frequency scales are provided for each cavity. Tuning is accomplished by sliding the hairline windows to the desired frequency, then adjusting the fine tuning and output coupling. Access to the interior of the amplifier is not required for tuning.
(3) If ambient temperature exceeds 90° F, the cavity body will become quite hot (up to 250° F), and forced air cooling is recommended.

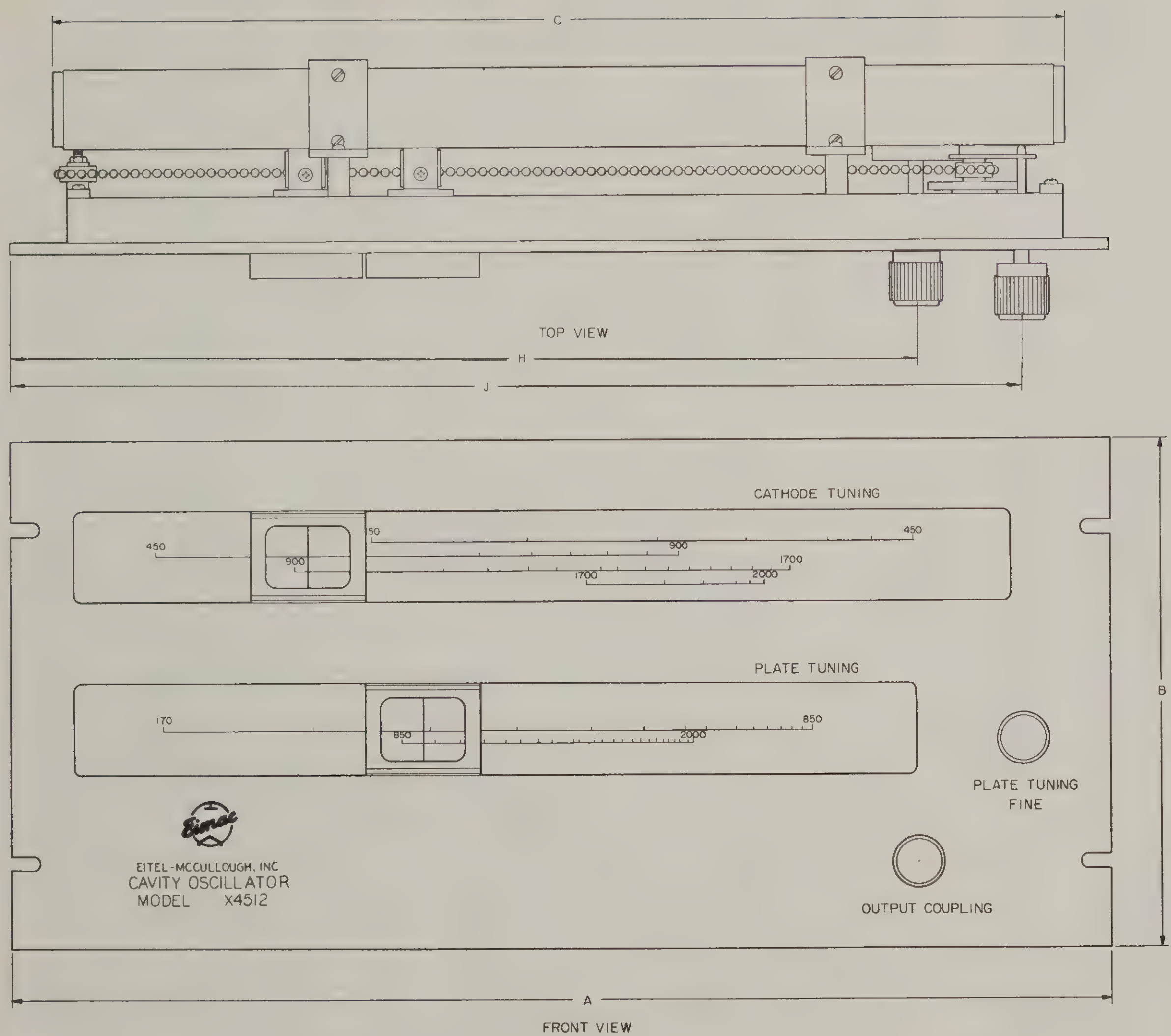
For personnel protection, high voltage circuits above 500 volts are enclosed and identified. Interlocks are not provided.



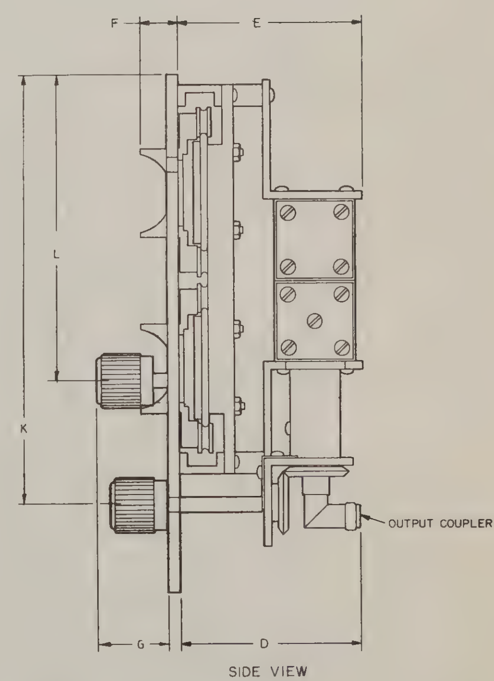
EM-4512 CAVITY OSCILLATOR
FIGURE 2



EM-4512 POWER SUPPLY CONNECTIONS
FIGURE 3



DIMENSION DATA		
REF	MIN	MAX
A	18.969	19.000
B	8.719	8.750
C	17.417	17.521
D	2.863	3.091
E	3.025	3.099
F	.589	.598
G	1.182	1.214
H	15.583	15.635
J	17.474	17.526
K	7.245	7.287
L	5.167	5.209



06890	EM-4512
CODE IDENT	PART NO

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

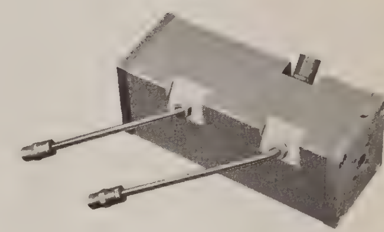
EM4524

CAVITY AMPLIFIER

2200-2300 Mc

80 WATTS CW

The Model EM4524 cavity amplifier is a compact modular amplifier readily adaptable to airborne or ground support telemetry and communications systems. The Model EM4524 is an optimum combination of the tube configuration with the associated RF circuit. Maximum efficiency and rf output from a very small package are outstanding features offered by this amplifier. Tuning can be accomplished with a minimum of test equipment.



CHARACTERISTICS

ELECTRICAL

Tuning Range	2200-2300 Mc
Tube Type	Eimac X843E

Power Supply Requirements:

Anode Voltage	1000	V
Current	250	mA
Heater Voltage	6.0	V
Current	2.1	A

Operating Characteristics:

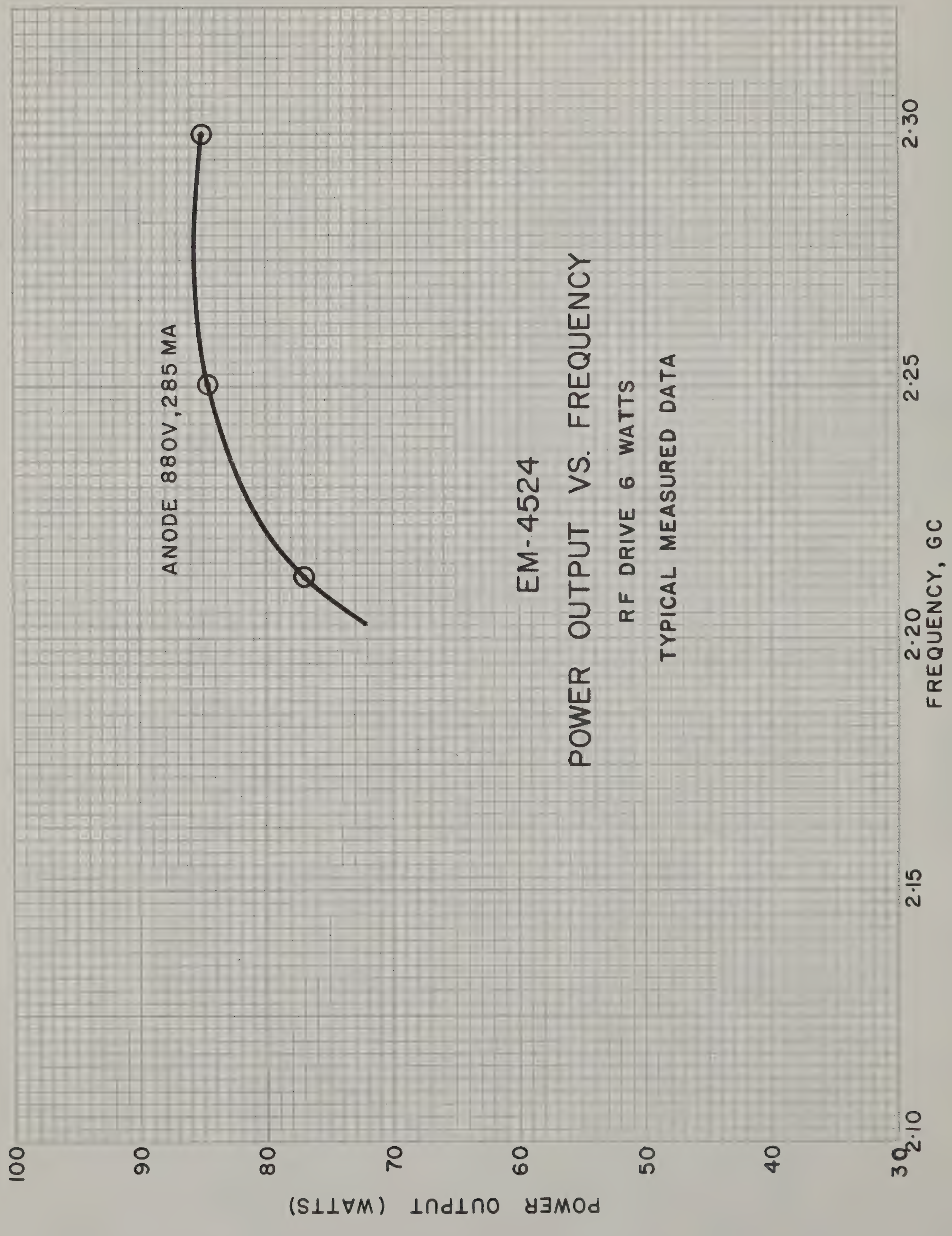
Power Input	8.0	W
Power Output	80	W
Modulation		CW/FM
Bandwidth, 3 db points	7	Mc
Frequency Stability	20	PPM/°C
Load Impedance	50	ohms nominal
Load VSWR	1.5:1	Any Constant Phase

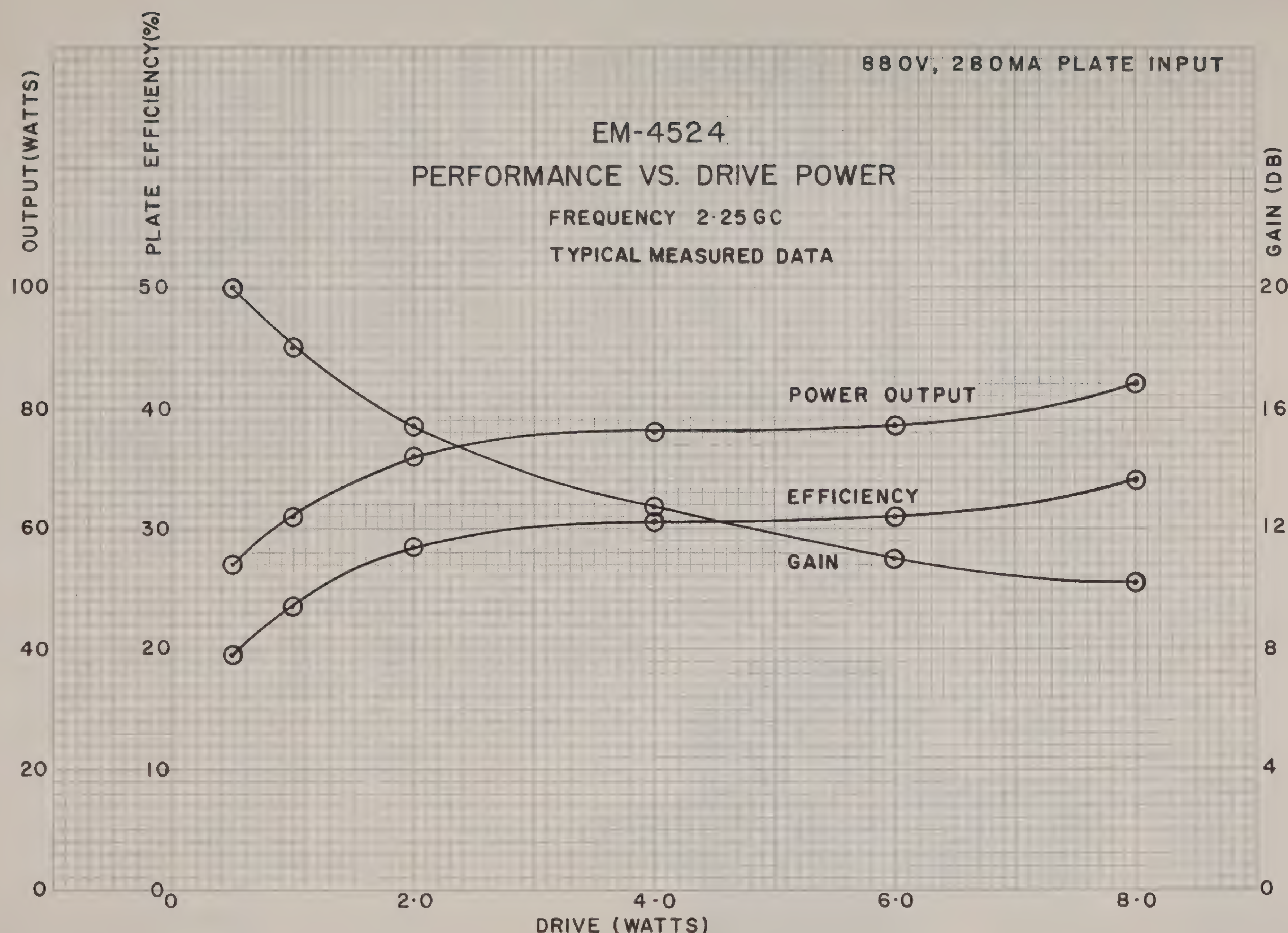
MECHANICAL

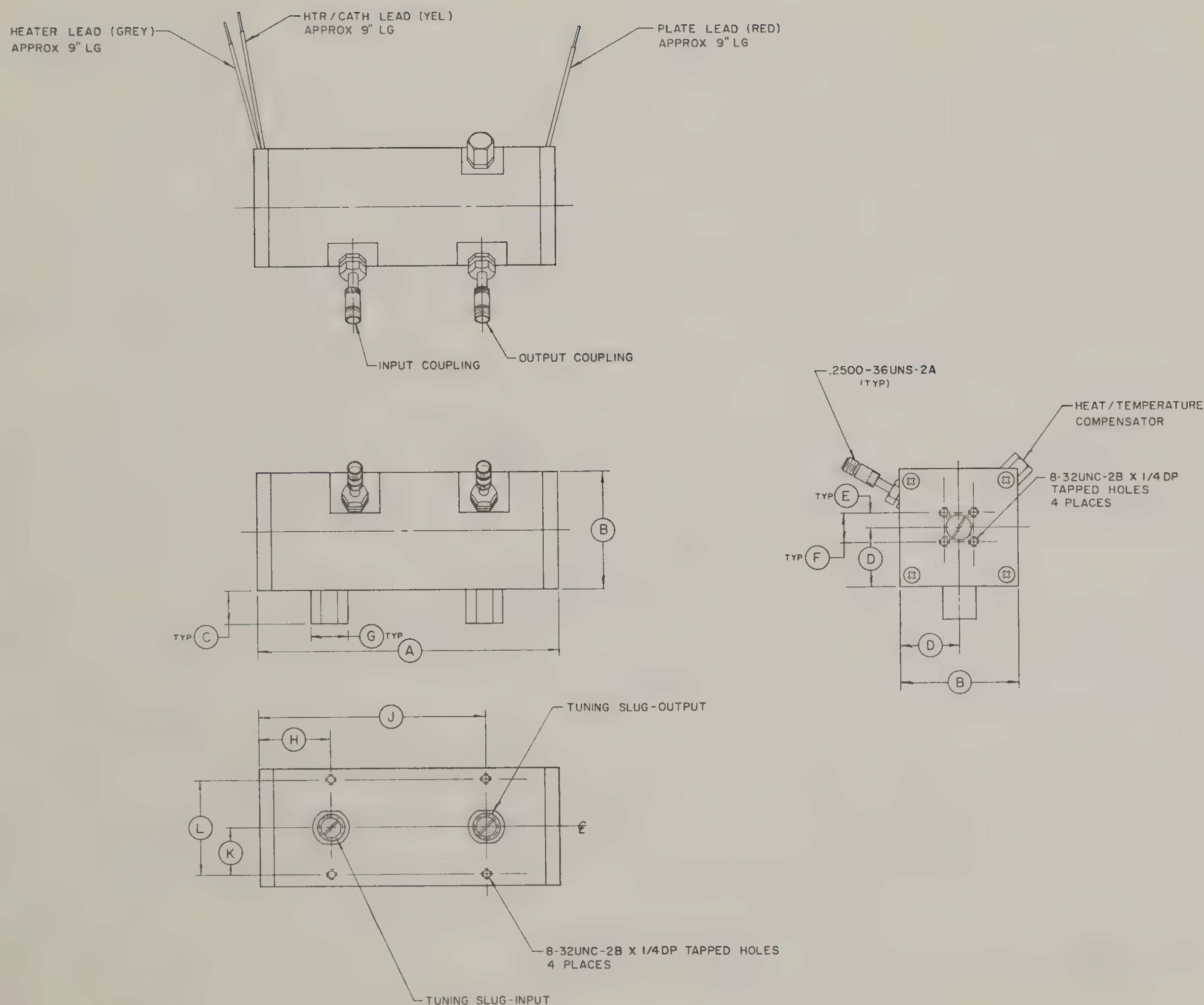
Connectors	Type BRM
Cooling	Conduction
Maximum Overall Dimensions	2" x 2" x 5.1"
Net Weight	2.5 pounds

ENVIRONMENTAL

Mounting Surface Temperature	−40 to +100°C
Vibration	Shall meet the requirements of Method 514, MIL-Standard-810, Class 1 through 4 and mounting Type A.
Shock	Shall meet the requirements of Procedure 1, Method 516 of MIL-Standard-810.


EM-4524
POWER OUTPUT VS. FREQUENCY
RF DRIVE 6 WATTS
TYPICAL MEASURED DATA
ANODE 880V, 285 MA
POWER OUTPUT (WATTS)
100
90
80
70
60
50
40
30
FREQUENCY, GC
2·10
2·15
2·20
2·25
2·30


EM-4524
PERFORMANCE VS. DRIVE POWER
FREQUENCY 2·25 GC
TYPICAL MEASURED DATA
880V, 280MA PLATE INPUT
OUTPUT (WATTS)
PLATE EFFICIENCY (%)
GAIN (DB)
POWER OUTPUT
EFFICIENCY
GAIN
DRIVE (WATTS)
0
2·0
4·0
6·0
8·0
100
80
60
40
20
50
40
30
20
10
20
16
12
8
4



DIMENSIONAL DATA			
REF	MAX	MIN	NOM
A	5.117	5.083	
B	2.005	1.995	
C	.585	.565	
D	1.005	.995	
E	.255	.245	
F	.505	.495	
G	.630 DIA	.620 DIA	
H	1.235	1.215	
J	3.845	3.825	
K	.805	.795	
L	1.605	1.595	

EITEL-McCULLOUGH, INC.

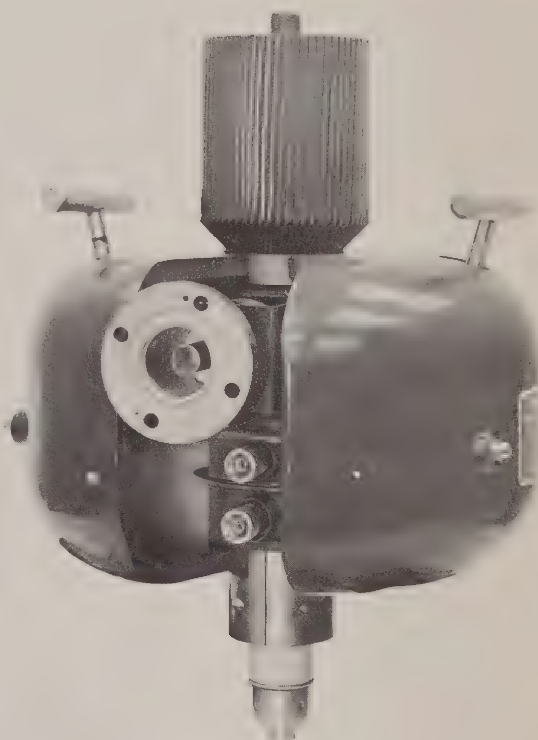
TENTATIVE DATA

4K3SK

POWER AMPLIFIER

S-BAND KLYSTRON

The Eimac 4K3SK is an air cooled, permanent magnet focused, power amplifier klystron designed to operate at frequencies from 2400 to 2700 megacycles. It will deliver a minimum output power of 1 kilowatt with a minimum power gain of 40 decibels. The 4K3SK is intended for use in applications where light weight and compactness are essential.



FEATURES

FREQUENCY - - - - - - - - -	2400-2700 Mc
MINIMUM OUTPUT POWER - - - -	1 kW
MINIMUM POWER GAIN - - - - -	40 db
HALF POWER BANDWIDTH - - - -	10 Mc

PERMANENT MAGNET FOCUSING
FOUR INTEGRAL CAVITIES
LOW NOISE LEVEL
FIXED INPUT AND OUTPUT COUPLING
PROVISION FOR SECOND CAVITY LOADING
TWO LIFTING HANDLES FOR EASE OF HANDLING
INSTANT FAULT RECYCLING

CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential

Starting Time - - - - - - - - - - - - - - - - - -	3	minutes
Heater: Voltage - - - - - - - - - - - - - - - - -	6	volts
Current - - - - - - - - - - - - - - - - - -	4.5	amperes

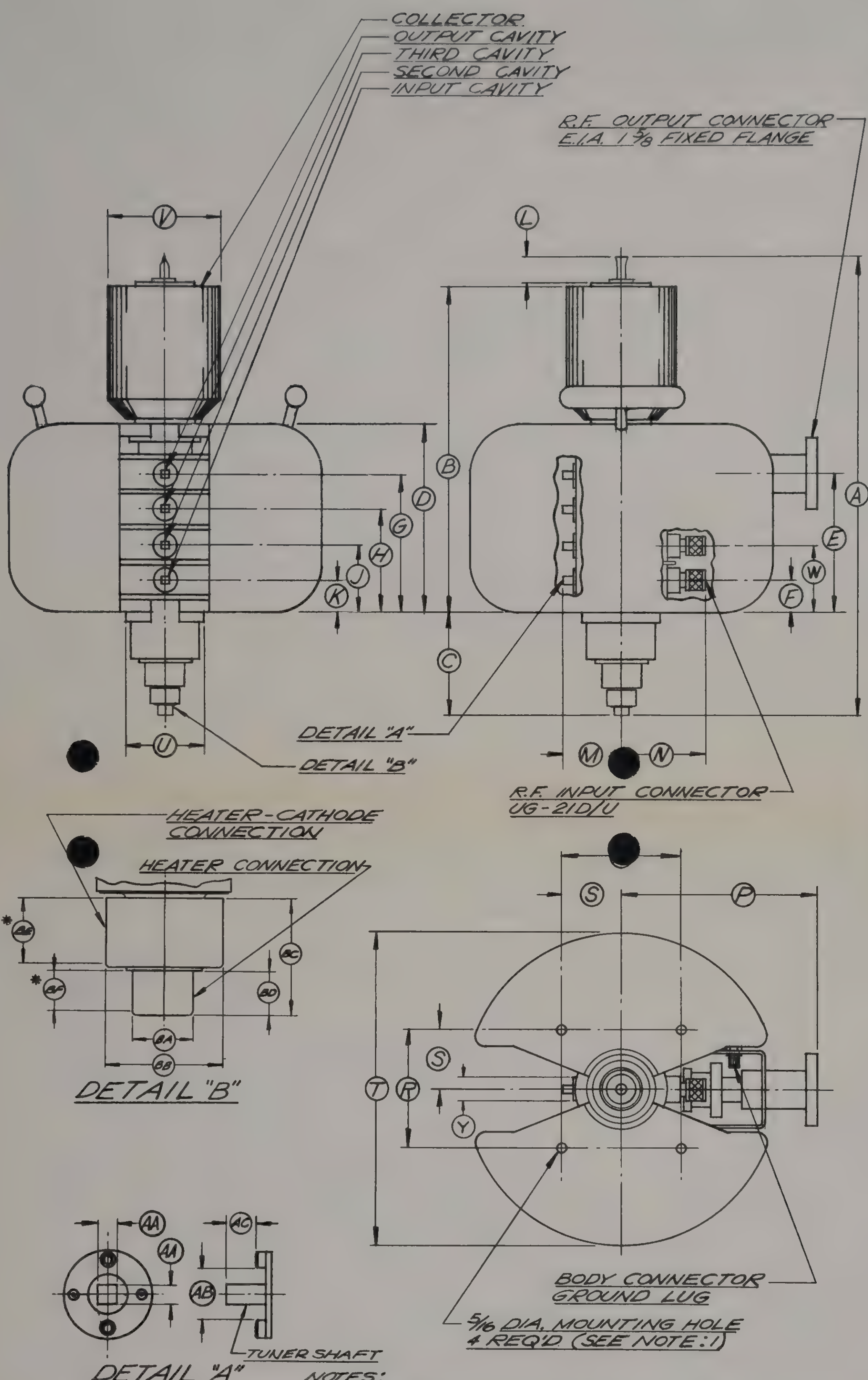
MECHANICAL

Operating Position (preferred) - - - - - - - - - - -	Vertical, cathode down
Tuner Starting Torque (maximum) - - - - - - - - - - -	12 inch pounds
Tuner Stop Torque (maximum) - - - - - - - - - - - - -	25 inch pounds

Cooling: Forced Air (20°C at sea level)

Collector Flow - - - - - - - - - - - - - - -	200	cfm
Collector Pressure Drop - - - - - - - - - - - -	1.75	inches H_2O

Body and Cathode seals require cooling only at higher temperatures or lower pressures.



DIMENSIONAL DATA			
REF	NOM.	MIN.	MAX.
A			19.000
B	13.475		
C	4.544		
D			7.874
E	5.820		
F	1.470		
G	5.820		
H	4.370		
J	2.920		
K	1.470		
L			.750
M	2.472		
N	3.475		
P	7.910		
R		4.888	5.012
S		2.444	2.506
T			13.196
U			3.042
V	4.383		
W	2.920		
Y		.900	
AA		.248	.252
AB		.647	
AC		.340	
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		.530	
BE		.830	
BF		.450	

NOTES:
1. KEEP MAGNETIC MATERIAL AT LEAST SIX INCHES AWAY FROM MAGNET; OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT SURFACES.
4. CYLINDER OF CLEARANCE TO BE CENTERED ON EACH TUNER SHAFT.

4K3SK KLYSTRON

4K3SK Eimac

MECHANICAL (continued)

Maximum Dimensions:	
Length	18.4 inches
Width	13.25 inches
Depth	14 inches
Input Coupling (rf)	UG-21 D/U Connector
Second Cavity Loading	UG-21 D/U Connector
Output Coupling (rf)	EIA 1-5/8 inch, 50-ohm coaxial
Weight (Klystron and Magnet)	85 pounds

MAXIMUM RATINGS

BEAM VOLTAGE (dc)	7	KILOVOLTS
BEAM CURRENT (dc)	0.6	AMPERE
BEAM INPUT POWER (dc)	4	KILOWATTS
COLLECTOR DISSIPATION	4	KILOWATTS
CATHODE SEAL TEMPERATURE	150	DEGREES C
LOAD VSWR	2:1	

TYPICAL OPERATION - TUNED FOR MAXIMUM EFFICIENCY

Frequency	2400	2550	2700	megacycles
Output Power	1.08	1.08	1.08	kilowatts
Driving Power	44	60	60	milliwatts
Gain	43.8	42.5	42.5	decibels
Second Cavity Loading	1	1	1.3	watt
Beam Voltage	6.5	6.5	6.5	kilovolts dc
Beam Current	0.58	0.58	0.58	ampere dc
3 db Bandwidth	10	12	15	megacycles

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

Eimac

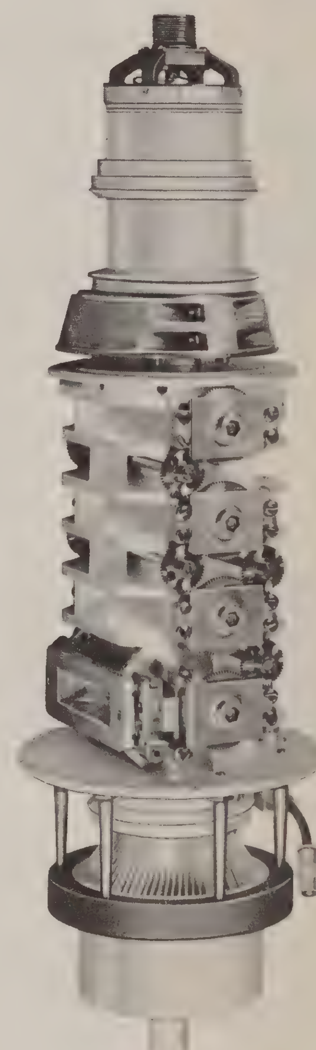
EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X700

PULSE AMPLIFIER

S-BAND KLYSTRON



The Eimac X700 is a four cavity, magnetically focused, pulse amplifier klystron designed for use under severe environmental conditions. This klystron will deliver a peak output power of 20 kilowatts, at 1 kilowatt average power, at frequencies from 2400 to 2900 megacycles. Typical power gain is 40 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. The electron-gun geometry is such that the modulating anode voltage is only 50% as great as the beam voltage.

The resonant cavities of the X700 are an integral part of the klystron but are completed and tuned outside the vacuum envelope.

Waveguide output coupling for the X700 is achieved by means of an adjustable iris in the output cavity.

The associated magnetic circuitry for the X700 includes a supporting structure, focusing coils, extension tuning controls, and a waveguide transition.

CHARACTERISTICS

ELECTRICAL

Cathode:	Oxide Coated, Unipotential		
	Minimum Heating Time	5	minutes
Heater:	Voltage ($\pm 5\%$)	7.5	volts
	Current	5.5	amperes
	Maximum Starting Current	11	amperes
Typical Power Gain		40	decibels
Peak Output Power		20	kilowatts
Average Output Power		1.0	kilowatt
Frequency Range		2400 to 2900	megacycles

MECHANICAL

Operating Position	Vertical, Cathode up	
RF Input Coupling	50-ohm TNC	
RF Output Coupling	WR-284 Waveguide	
Weight (X700)	39	pounds
Weight (Circuit Assembly)	160	pounds
Maximum Dimensions (X700)		
Length	24	inches
Diameter	7	inches
Maxmum Dimensions (X700 and circuit assembly)		
Length	24	inches
Diameter	17	inches

Cooling: Forced Air	Flow Rate	Pressure Drop
Body	100 cfm	1.5 inches H_2O
Collector	100 cfm	1.5 inches H_2O

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 40	volts
	Current	0 to 2	amperes
Each of Two Body Coils:			
	Voltage	0 to 40	volts
	Current	0 to 10	amperes
Collector Coil:	Voltage	0 to 50	volts
	Current	0 to 5	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	28	KILOVOLTS
PEAK BEAM CURRENT	36.5	AMPERES
PEAK MODULATING-ANODE VOLTAGE	14	KILOVOLTS
AVERAGE DC BODY CURRENT	50	MILLIAMPERES
COLLECTOR DISSIPATION	2500	WATTS
DC FOCUS-ELECTRODE VOLTAGE	—500	VOLTS

TYPICAL OPERATION, NARROW-BAND, PULSE AMPLIFIER

Frequency	2500	megacycles
DC Beam Voltage	21	kilovolts
Peak Modulating-Anode Voltage	10.5	kilovolts
Peak Beam Current	2.77	amperes
Average DC Beam Current	0.138	ampere
Average DC Body Current	25	milliamperes
Peak Output Power	21.5	kilowatts
Average Output Power	1.07	kilowatts
Peak Drive Power	2	watts
Power Gain	40.2	decibels
Peak Beam Power Efficiency	37	percent
Focus-Electrode Voltage	—100	volts
Pulse Width	50	microseconds
Pulse Repetition Rate	1000	pulses/second
Duty	0.05	
Magnetic Coil Currents:		
Prefocus Coil	1.2	amperes
First Body Coil	7.0	amperes
Second Body Coil	7.0	amperes
Collector Coil	3.2	amperes

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

Eimac®

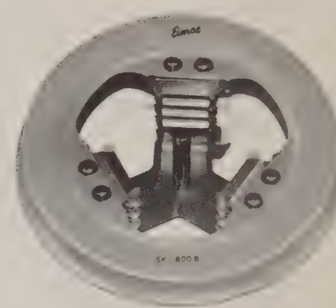
EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

SK-800B
AIR-SYSTEM SOCKET UNGROUNDED CATHODE TERMINALS
SK-806
AIR CHIMNEY

The Eimac SK-800B is one of the air-system sockets recommended for use with the Eimac 4CX1000A or 4CW2000A tetrodes. A companion SK-806 Air Chimney is also available and is recommended for use with the socket when the air-cooled 4CX1000A is to be employed.

When this socket is used, connection is made to each of the tube electrodes, except the anode, and to one side of the integral screen-grid by-pass capacitor. The SK-800B is humidity and salt-spray resistant.

The SK-800B is an improved version of the SK-800A and directly replaces the SK-800A in any equipment. The SK-800B features a stronger, one piece base and improved contact tabs.



SK-800B

BASE CONNECTIONS

The SK-800B socket consists of three sets of spring-finger contact tabs for each tube electrode (to assure low-inductance contact), a center guide pin to facilitate tube installation, and an integral screen by-pass capacitor. The terminals are shown on the outline drawing.

When the socket is mounted on a grounded chassis, no tube electrodes are automatically grounded. Connection to the cathode and one side of the heater is made via the second set of spring-finger contacts from the bottom of the socket.

SK-800B WITH CHIMNEY

SCREEN-GRID BY-PASS CAPACITOR

This capacitor utilizes Mylar film as a dielectric and is encapsulated in silicone resin. Its capacitance is 1500 uufds ± 20 percent and it is rated at 400 dc working volts. One side connects to the three screen-grid tabs on the tube and the other side is connected directly to the socket body.

MATERIALS AND FINISHES

The metal shell, or body, of the socket is fabricated of silver-plated brass, while the mounting base and centering pin are a one-piece, nickel-plated die casting. All contacts are formed of a non-ferrous alloy, heat-treated and silver-plated. Contact insulating material is high-temperature ceramic.

INSTALLATION

The SK-800B Air-System Socket is designed for under-chassis mounting and requires a 5-1/16-inch hole through the chassis deck. The socket is held in place by the three toe clamps provided. One side of the screen-grid by-pass capacitor is automatically grounded to the chassis when this mounting method is used.

AIR CHIMNEY

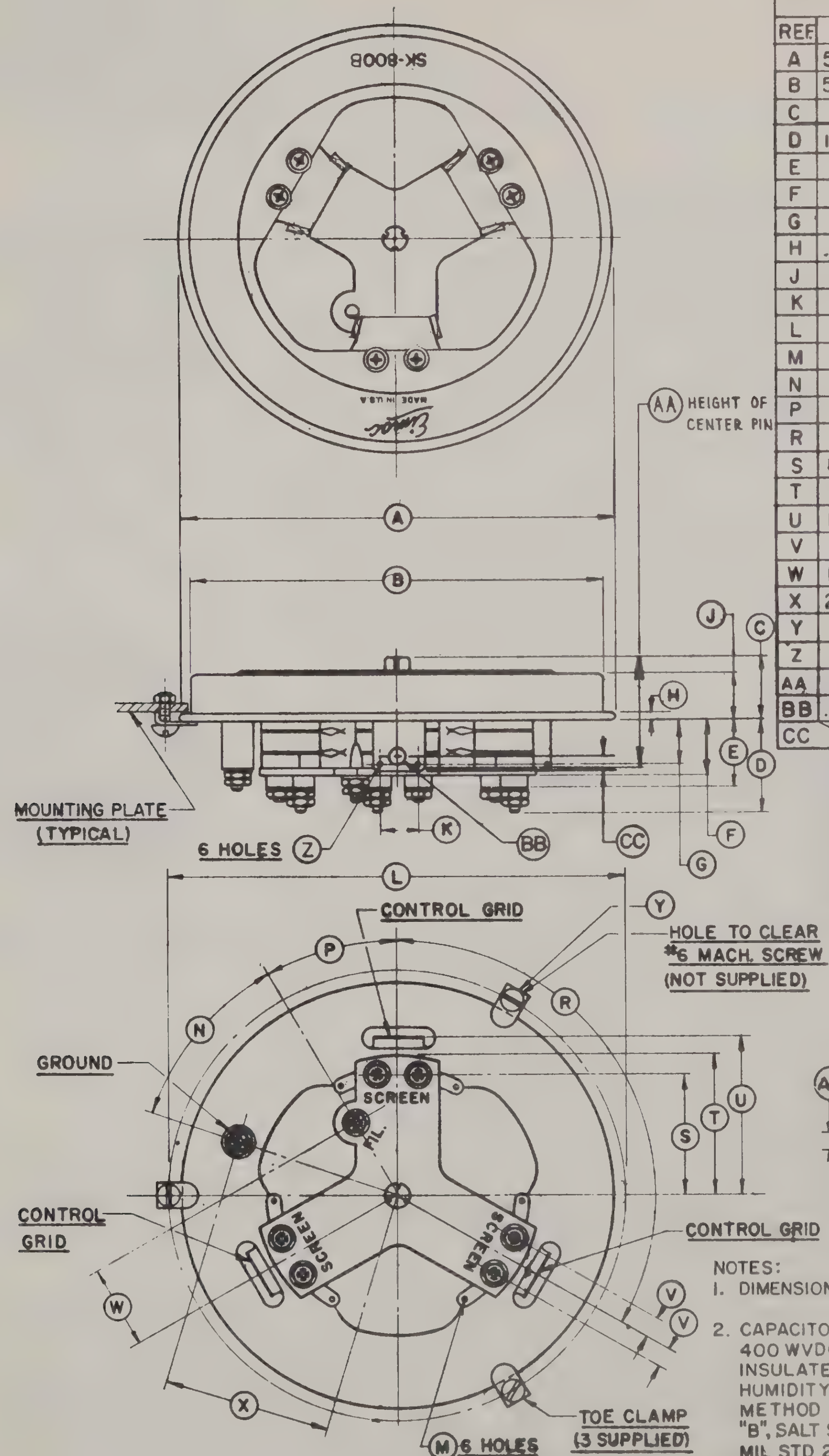
The SK-806 Air Chimney is moulded of fiberglass-reinforced silicone resin. It effectively directs the flow of air to the anode cooling fins with minimum pressure drop and is recommended for use with each SK-800B when the air-cooled 4CX1000A is to be socketed.

SK-800B:

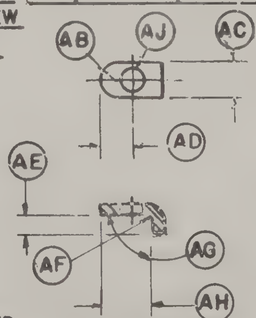
Net Weight - 18 ounces

SK-806:

Net Weight - 3-1/4 ounces
Maximum Height - 1-7/8 inches
Maximum Diameter - 6-1/8 inches



DIMENSION DATA			
REF.	MIN.	MAX.	NOM.
A	5.290	5.330	
B	5.027	5.047	
C	.690	.730	
D	1.100	1.170	
E			.760 REF
F	.641	.681	
G	.500	.540	
H	.110	.140	
J	.510	.540	
K	.422	.452	
L			5.595 REF
M	.057 DIA.	.077 DIA.	
N	40°	42°	
P	29°	31°	
R	119°	121°	
S	1.490	1.530	
T	1.699	1.739	
U	1.917	1.957	
V	.245	.255	
W	1.052	1.072	
X	2.052	2.072	
Y	.142 DIA.		
Z	.078 DIA.	.108 DIA.	
AA	1.246	1.286	
BB	.156 DIA.	.186 DIA.	
CC			.234 REF
AB	.125 R	.187 R	
AC	.292	.332	
AD	.292	.332	
AE	.105	.145	
AF		.062 R	
AG	80°	100°	
AH	.417	.457	
AJ	.142	.146	



TOE CLAMP DETAIL

NOTES:
1. DIMENSIONS IN INCHES.
2. CAPACITOR: 1500 MMFD ± 20% 400 WVDC, 1000 VDC TEST INSULATED TO WITHSTAND HUMIDITY PER MIL-STD-202, METHOD 103A, TEST CONDITION "B", SALT SPRAY PER MIL STD 202, METHOD 101A.

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

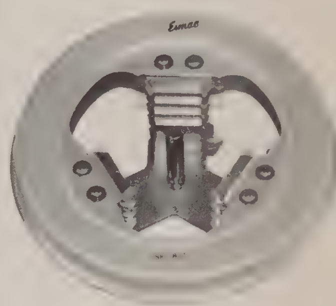
SK-810B
AIR-SYSTEM SOCKET
GROUNDED
CATHODE TERMINALS

SK-806
AIR CHIMNEY

The Eimac SK-810B is one of the air-system sockets recommended for use with the Eimac 4CX1000A or 4CW2000A tetrodes. A companion SK-806 Air Chimney is also available and is recommended for use with the socket when the air-cooled 4CX1000A is to be employed.

When this socket is used, connection is made to each of the tube electrodes except the anode, and to one side of the integral screen-grid by-pass capacitor. The SK-810B is humidity and salt-spray resistant.

The SK-810B is an improved version of the SK-810 and directly replaces the SK-810 in any equipment. The SK-810B features a stronger, one-piece base and improved contact tabs.



SK-810B

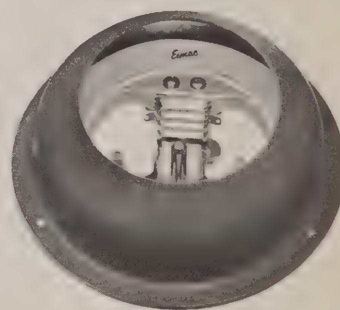
BASE CONNECTIONS

The SK-810B socket consists of three sets of spring-finger contact tabs for each tube electrode (to assure low-inductance contact), a center guide pin to facilitate tube installation, and an integral screen by-pass capacitor. The terminals are shown on the outline drawing.

When this socket is mounted on a grounded chassis, the cathode and one side of the heater will be automatically grounded. A grounding terminal is provided and may be used for positive connection if desired.

SCREEN GRID BY-PASS CAPACITOR

This capacitor utilizes Mylar film as a dielectric and is encapsulated in silicone resin. Its capacitance is 1500 uufds ± 20 percent and it is rated at 400 dc working volts. One side connects to the three screen-grid tabs on the tube and the other side is connected directly to the socket body.



SK-810B WITH CHIMNEY

MATERIALS AND FINISHES

The metal shell, or body, of the socket is fabricated of silver-plated brass, while the mounting base and centering pin are a one-piece, nickel-plated die casting. All contacts are formed of a non-ferrous alloy, heat-treated and silver-plated. Contact insulating material is high-temperature ceramic.

INSTALLATION

The SK-810B Air-System Socket is designed for under-chassis mounting and requires a 5-1/16-inch hole through the chassis deck. The socket is held in place by the three toe clamps provided. One side of the screen-grid by-pass capacitor is automatically grounded to the chassis when this mounting method is used.

AIR CHIMNEY

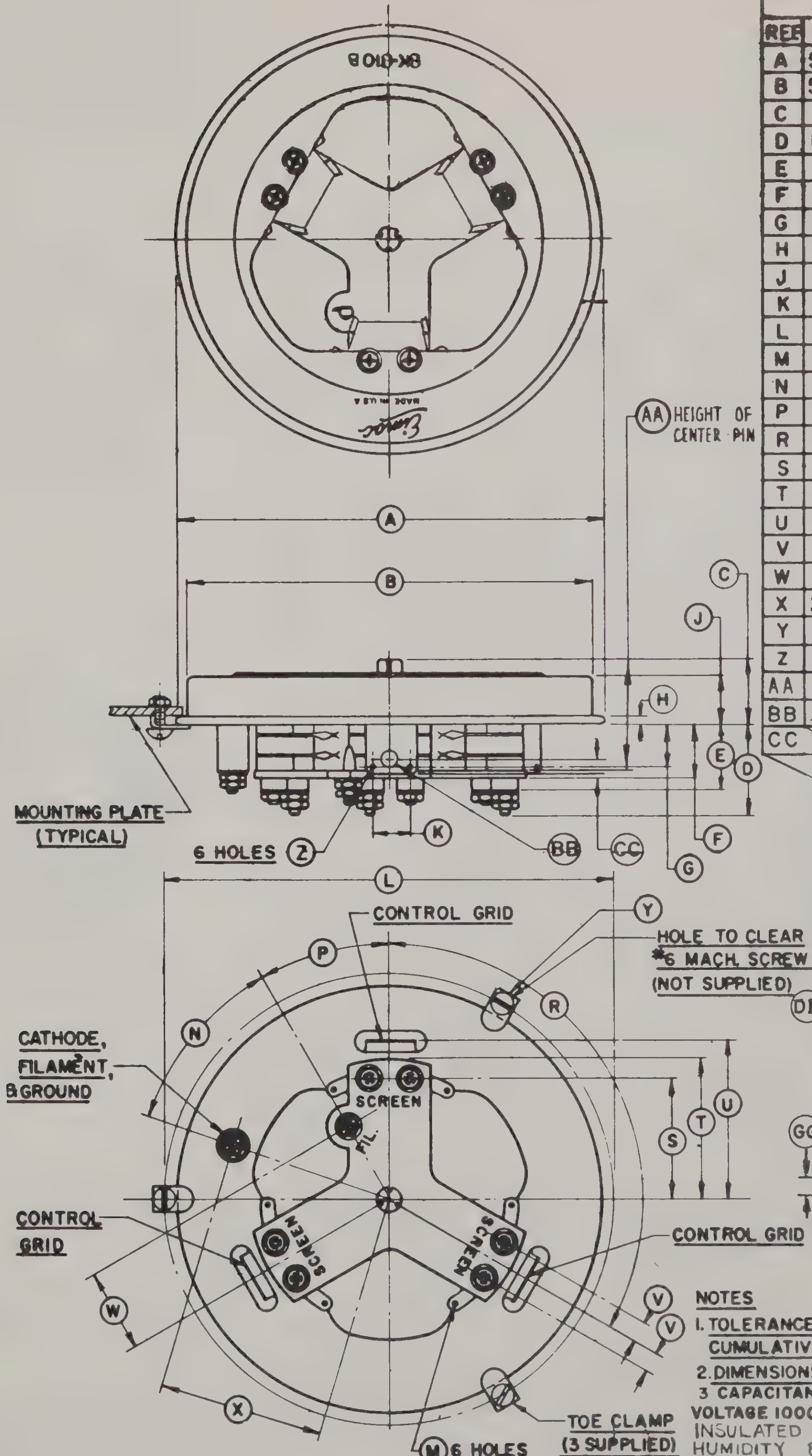
The SK-806 Air Chimney is molded of fiberglass-reinforced silicone resin. It effectively directs the flow of air to the anode cooling fins with minimum pressure drop and is recommended for use with each SK-810B when the air-cooled 4CX1000A is to be socketed.

SK-810B

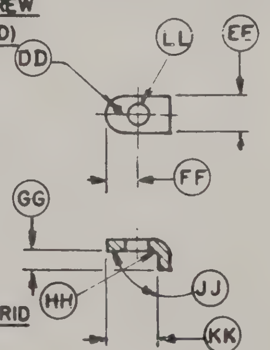
Net Weight - 18 ounces

SK-806:

Net Weight - 3-1/4 ounces
Maximum Height - 1-7/8 inches
Maximum Diameter - - - - - - - - - - - - - - - - - - - 6-1/8 inches



REF	MIN.	MAX.	NOM.
A	5.290	5.330	
B	5.027	5.047	
C	.690.	.730	
D	1.100	1.170	
E			.760
F	.641	.681	
G	.500	.540	
H	.110	.140	
J	.510	.540	
K	.422	.432	
L			5.595
M	.057 DIA.	.077 DIA.	
N	40°	42°	
P	29°	31°	
R	119°	121°	
S	1.490	1.530	
T	1.699	1.739	
U	1.917	1.957	
V	.245	.255	
W	1.052	1.072	
X	2.052	2.072	
Y	.142 DIA.		
Z	.078 DIA.	.108 DIA.	
AA	1.246 -	1.286	
BB	.156 DIA.	.186 DIA.	
CC			.234
DD	.125R	.187R	
EE	.292	.332	
FF	.292	.332	
GG	.105	.145	
HH		.062R	
JJ	80°	100°	
KK	.417	.457	
LL	.142	.146	



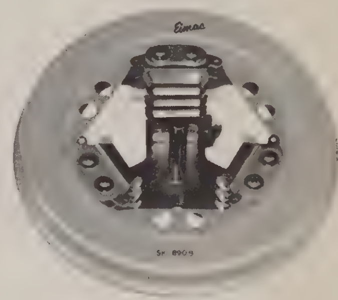
TOE CLAMP DETAIL

NOTES

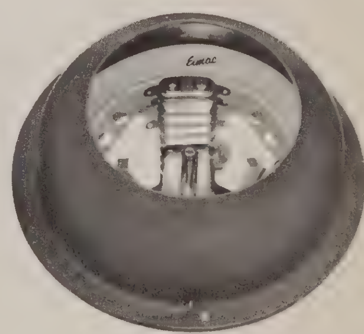
1. TOLERANCES ARE NOT CUMULATIVE.
2. DIMENSIONS IN INCHES.
3. CAPACITANCE 1500MMFD ± 20% VOLTAGE 1000VDC TEST, 400WVDC INSULATED TO WITHSTAND HUMIDITY & SALT SPRAY MIL STD-202B.

SK-890B
AIR-SYSTEM SOCKET
GROUNDED
CATHODE TERMINALS

SK-806
AIR CHIMNEY



SK-890B



SK-890B WITH CHIMNEY

The Eimac SK-890B is one of the air-system sockets recommended for use with the Eimac 4CX1000A or 4CW2000A tetrodes. The SK-890B is especially designed for use at frequencies where series screen neutralization is employed and is so constructed that the screen-grid can be series tuned to ground through the screen by-pass capacitor. A companion SK-806 Air Chimney is also available and is recommended for use with the socket when the air-cooled 4CX1000A is to be employed.

When this socket is used, connection is made to each of the tube electrodes except the anode. The SK-890B is humidity and salt-spray resistant.

The SK-890B is an improved version of the SK-890 and directly replaces the SK-890 in any equipment. The SK-890B features a stronger, one-piece base and improved contact tabs.

BASE CONNECTIONS

The SK-890B socket consists of three sets of spring-finger contact tabs for each tube electrode (to assure low-inductance contact), a center guide pin to facilitate tube installation, and an integral screen by-pass capacitor. The terminals are shown on the outline drawing.

When this socket is mounted on a grounded chassis, the cathode and one side of the heater will be automatically grounded. A grounding terminal is provided and may be used for positive connection if desired.

SCREEN-GRID BY-PASS CAPACITOR

This capacitor utilizes Mylar film as a dielectric and is encapsulated in silicone resin. Its capacitance is 1500 uufds $\pm$20 percent and it is rated at 400 dc working volts. The socket is so orientated that the three sets of spring finger contacts which connect to the screen-grid tabs of the tube are not connected to the upper, ungrounded side of the screen-grid capacitor. A series of six holes are provided to the upper capacitor deck to allow the installation of the screen neutralizing device; this device is connected between each of the solder terminals provided in the screen spring finger contacts and the upper capacitor deck. The lower capacitor deck is connected directly to the socket body.

MATERIALS AND FINISHES

The metal shell, or body, of the socket is fabricated of silver-plated brass, while the mounting base and centering pin are a one-piece, nickel-plated die-casting. All contacts are formed of a non-ferrous alloy, heat-treated and silver-plated. Contact insulating material is high-temperature ceramic.

INSTALLATION

The SK-890B Air-System Socket is designed for under-chassis mounting and requires a 5-1/16-inch hole through the chassis deck. The socket is held in place by the three toe clamps provided. One side of the screen-grid by-pass capacitor is automatically grounded to the chassis when this mounting method is used.

AIR CHIMNEY

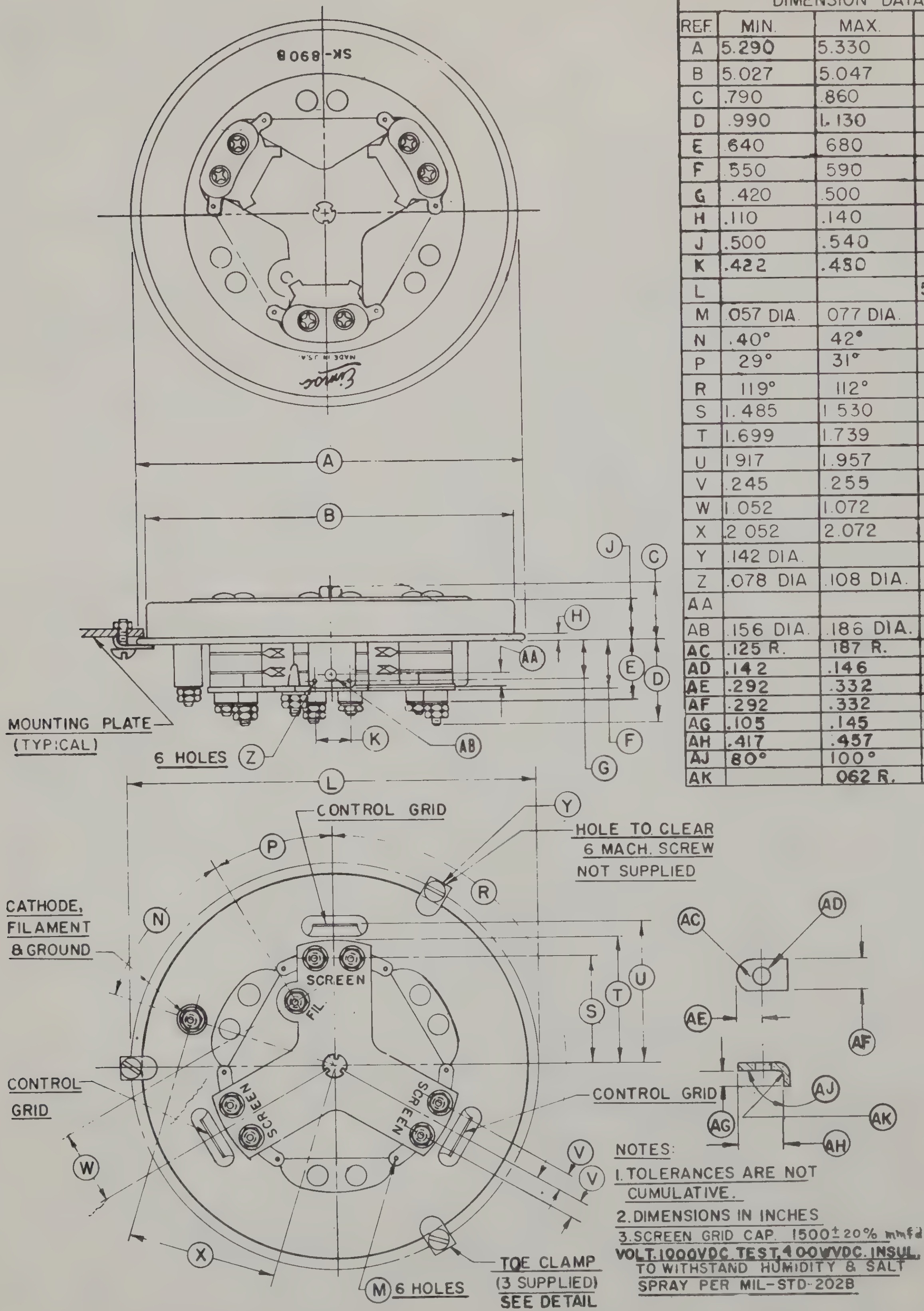
The SK-806 Air Chimney is moulded of fiberglass-reinforced silicone resin. It effectively directs the flow of air to the anode cooling fins with minimum pressure drop and is recommended for use with each SK-890B when the air-cooled 4CX1000A is to be socketed.

SK-890B:

Net Weight - 18 ounces

SK-806:

Net Weight - 3-1/4 ounces
Maximum Height - 1-7/8 inches
Maximum Diameter - 6-1/8 inches



DIMENSION DATA			
REF.	MIN.	MAX.	NOM.
A	5.290	5.330	
B	5.027	5.047	
C	.790	.860	
D	.990	1.130	
E	.640	680	660
F	.550	590	
G	.420	.500	
H	.110	.140	
J	.500	.540	
K	.422	.480	
L			5.595
M	.057 DIA.	077 DIA.	
N	40°	42°	
P	29°	31°	
R	119°	112°	
S	1.485	1 530	
T	1.699	1.739	
U	1.917	1.957	
V	.245	.255	
W	1.052	1.072	
X	2.052	2.072	
Y	.142 DIA.		
Z	.078 DIA	.108 DIA.	
AA			.234
AB	.156 DIA.	.186 DIA.	
AC	.125 R.	187 R.	
AD	.142	.146	
AE	.292	.332	
AF	.292	.332	
AG	.105	.145	
AH	.417	.457	
AJ	80°	100°	
AK		062 R.	

NOTES:

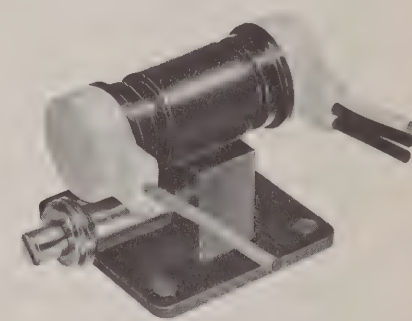
1. TOLERANCES ARE NOT CUMULATIVE.
2. DIMENSIONS IN INCHES
3. SCREEN GRID CAP. 1500±20% mmfd VOLT. 1000VDC. TEST, 400WVDC. INSUL. TO WITHSTAND HUMIDITY & SALT SPRAY PER MIL-STD-202B

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XF-B

X BAND
REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	10.061 to 10.452 Gc
Mechanically tunable	391 Mc
Power output	40 mW min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	300 Vdc
Cathode current	25 mA
Repeller voltage	−80 to −120 Vdc
Modulation sensitivity	3.0 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	0.7 A max.
Mode	5¾
VSWR of load	1.1:1
Temperature coefficient	−200 +100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	400 Vdc
Cathode current	50 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-52U wave-guide flange
Cooling required	conduction
Net weight	5 oz. max.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100° C
Altitude	100,000 ft.
Vibration*	10G, 20 to 2000 cps
Shock*	40G, 11 ms

*As required

OUTLINE DIMENSIONS

Height	1.400 in.
Width	1.625 in.
Length	2.570 in.

APPLICATION

NOTE: All voltages are referred to the cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150° C. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175° Centigrade.

Resonator: The resonator of the 1K20XF-B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

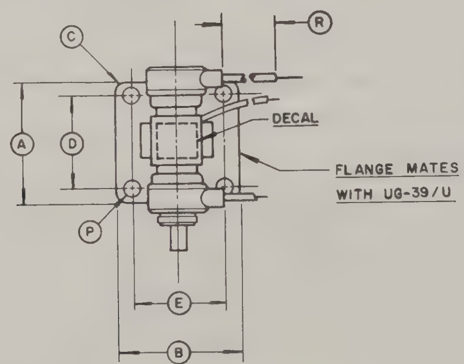
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the 1K20XF-B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2,000 cps) or shock of up to 40g (11 milliseconds duration).

With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 200 kilocycles.

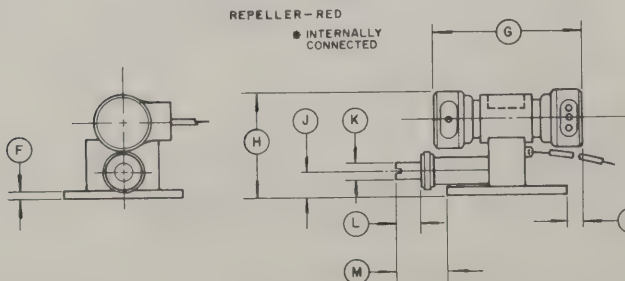
Special Applications: For additional information regarding any specific application, write to Microwave Division, Eitel-McCullough, Inc., San Carlos, California, telephone Lytell 1-1451, Cable EIMAC.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF	MIN	MAX	NOM
A			1.625
B			1.625
C			.125 R.
D	1.276	1.284	
E	1.216	1.224	
F			.125
G			1.958
H		1.400	
J			.340
K	.245	.250	
L	.290		
M		.800	
N		.187	
P	.169	.174	
R	12±1 TYP LEAD LENGTH		

CONNECTIONS
BODY – BROWN
HEATER – WHITE
* CATHODE – BLACK
* HEATER – BLACK
REPELLER – RED
* INTERNALLY CONNECTED



EITEL-McCULLOUGH, INC.

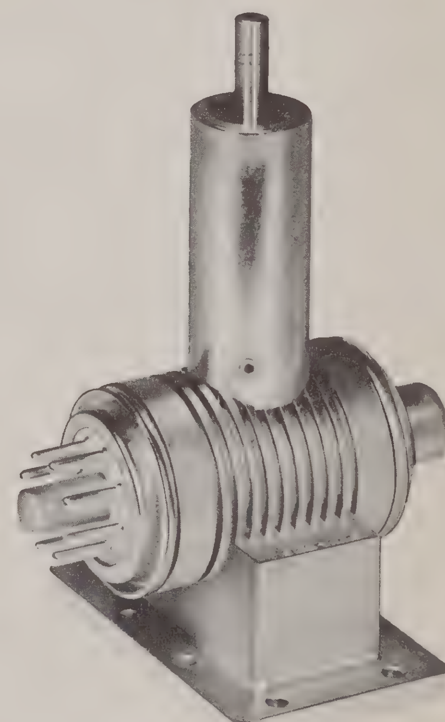
PRELIMINARY DATA

1K125CA

C-BAND

REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency Range - -	3.7 to 4.4 Gc
Mechanically Tunable	700 Mc
Power Output - - -	1.25 W min
Electronic Tuning Range (3 db bandwidth) -	25 Mc min
Resonator Voltage -	1000 Vdc
Cathode Current - -	80 mAdc
Repeller Voltage - -	—400 Vdc
Modulation Sensitivity	250 to 550 Kc/v
Heater Voltage - -	6.3 V(ac or dc)±5%
Heater Current - -	1.5 A max
Mode - - - - -	2-3/4
VSWR of Load - - -	1.15:1
Temperature Coefficient	±75 Kc/°C
Warm-up Time - -	120 seconds
[redacted] - - - - - - -	[redacted]

MAXIMUM RATINGS

Resonator Voltage - - - - - -	1200 Vdc
Cathode Current - - - - - -	110 mA
Repeller Voltage (negative with respect to the cathode) - - -	—100 to —750 Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position - - - - -	any
Electrical Connection - - - -	Octal Socket
RF Output Coupling -	CMR 187 waveguide flange
Cooling Required - - - - - -	10 cfm @ sea level
Net Weight - - - - - - - - -	19 ounces
Shipping Weight (approximate) - -	5 pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range (Ambient) -	—25 to +65 C
Altitude - - - - - - -	10,000 ft. max
Vibration - - - - - - -	10 G, 40 cps
Shock - - - - - - - -	10 G, 1 ms

OUTLINE DIMENSIONS

Height - - - - - - - - - -	4.700 max
Width - - - - - - - - - -	2.797 max
Length - - - - - - - - - -	3.450 max

APPLICATION NOTES

NOTE: All voltages are referred to the cathode.

COOLING: At sea level, with an ambient temperature of 50° Centigrade, a minimum air-flow rate of 10 CFM, directed over the klystron body, is required to adequately cool the tube when operated at maximum ratings.

For conditions other than the above, the criterion for proper cooling is to maintain the klystron ceramic-to-metal seal temperatures below 175° Centigrade. Cooling in excess of the minimum recommended flow rate will result in longer tube life and more stable operation. If extended tube life is of primary concern, the body temperature should not exceed 100° Centigrade.

RESONATOR: The resonator of the 1K125CA is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the 1K125CA are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

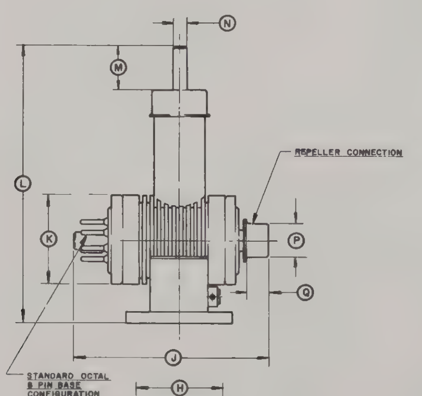
Electrical connection to the cathode of this tube should be completed by utilizing all four of the cathode base pins.

MECHANICAL TUNING: A screw-driven bellows, coupled to a ceramic-slug tuner, allows tuning cycling in excess of 1000 cycles without damage to the vacuum seals. The tuning rate of approximately 100 megacycles per turn and the low tuner starting-torque permits the use of miniature motors for remote tuning. Mechanical stops, capable of withstanding a maximum torque of 10 inch-ounces, are provided at the extremes of the tuning range to prevent damage to the tube.

Clockwise rotation of the tuner-shaft produces an increase in frequency.

MOUNTING: The 1K125CA should be mounted by the output-waveguide flange. An octal socket is required to complete the electrical connections to the heater and cathode. The repeller connection is completed with a standard medium cap connector.

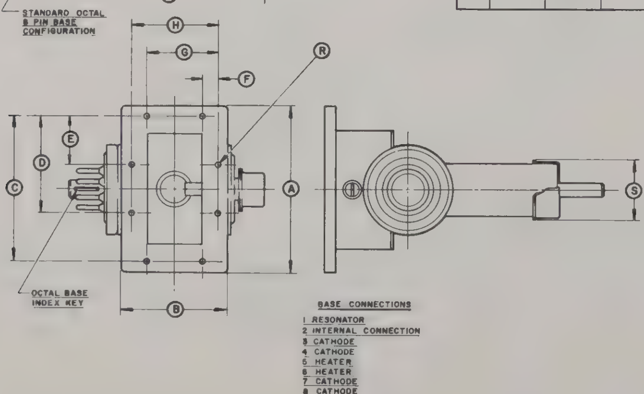
SPECIAL APPLICATIONS: For additional information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.



DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	2 765	2 797	
B	1.765	1 797	
C	2 426	2 434	
D	1.616	1624	
E	.806	.814	
F	.243	251	
G	1.179	1.187	
H	1.426	1.434	
J		3.450	
K			1.500 DIA.
9 L		4.700	
M	.400		
N	.248 DIA	250 DIA.	
P	.559 DIA.	573 DIA.	
Q	.370		
R	.147 DIA. TYP.		
9 S		1.050	



EITEL-McCULLOUGH, INC.

TENTATIVE DATA

EM-1114

X-BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting	13.90 Gc
Mechanically Trimmable	±20 Mc
Power Output	200 mW
Electronic Tuning Range (3 db bandwidth)	25 Mc min
Resonator Voltage	400 Vdc
Cathode Current	40 mA
Repeller Voltage	—280 Vdc
Modulation Sensitivity	0.8 Mc/v max
Heater Voltage	6.3 V(ac or dc)±5%
Heater Current	1.3 A max
Mode	3-3/4
VSWR of Load	1.10:1
Temperature Coefficient	—150 Kc/°C
Warm-up Time	30 seconds
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator Voltage	500 Vdc
Cathode Current	55 mA
Repeller Voltage (negative with respect to the cathode)	(-50 to -500) Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Electrical Connections	Flexible Lead
RF Output Coupling	RG-91/U waveguide
Cooling Required	Conduction
Net Weight	6 ounces
Shipping Weight (approximate)	4 pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range (Max Ambient)	150°C
Altitude	100,000 ft. max
Vibration	10 G, (20-2000 cps)
Shock	40 G, (11 ms)

OUTLINE DIMENSIONS

Height	1.40 inches
Width	1.50 inches
Length	2.10 inches

APPLICATION NOTES

COOLING: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150° C. The waveguide flange connection will normally provide the required heat-sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175° Centigrade.

RESONATOR: The resonator of the EM-1114 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

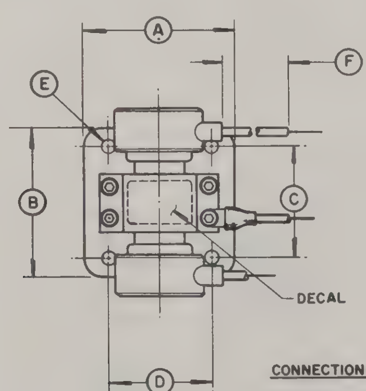
The heater and cathode of the EM-1114 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

MECHANICAL TRIMMING: The EM-1114 is fitted with a locking tuner that allows ±20 mc trimming. The center frequency is factory pre-set to your specification.

SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2,000 cps) or shock of up to 40g (11 milliseconds duration).

With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 200 kilocycles.

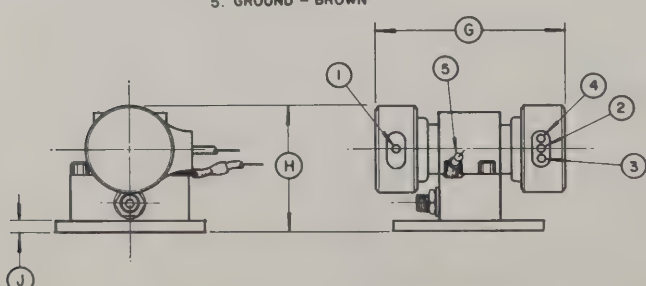
SPECIAL APPLICATIONS: For additional information regarding any specific application, write to Microwave Division, Eitel-McCullough, Inc., San Carlos, California, telephone Lytell 1-1451, Cable EIMAC.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER – GREY
2. HEATER – YELLOW
3. CATHODE – GREEN
4. HEATER CATHODE – WHITE
5. GROUND – BROWN



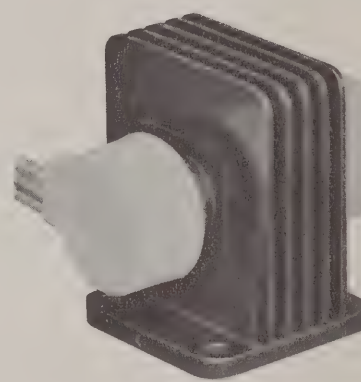
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1118A

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	10.7 to 11.2 Gc
Mechanically tunable	500 Mc
Power output	100 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	400 Vdc
Cathode current	40 mAdc
Repeller voltage	−150 Vdc
Modulation sensitivity	2.0 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	4¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	60 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.8 in.
Width	1.5 in.
Length	2.5 in.

(EFFECTIVE 4-1-64)

APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

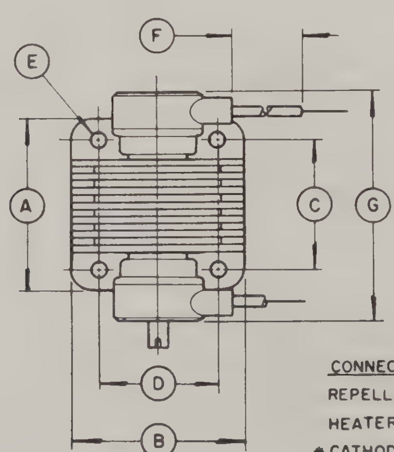
Resonator: The resonator of the X1118A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1118A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1118A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

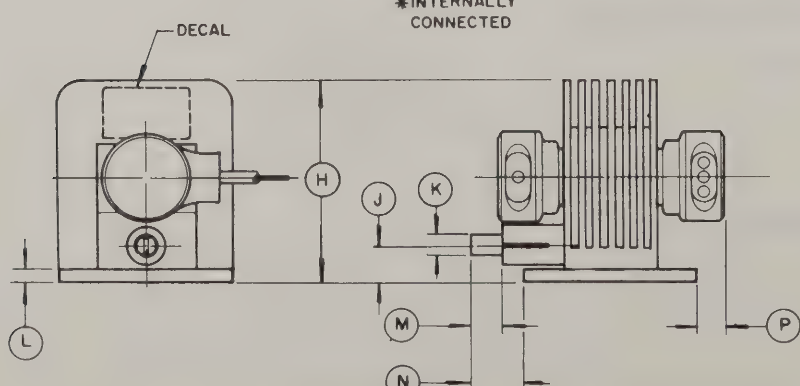
A clockwise rotation of the tuner will produce a decrease in frequency.



DIMENSIONS IN INCHES

DIMENSIONAL DATA •			
REF.	MIN.	MAX.	NOM
A			1 500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.800	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	

CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

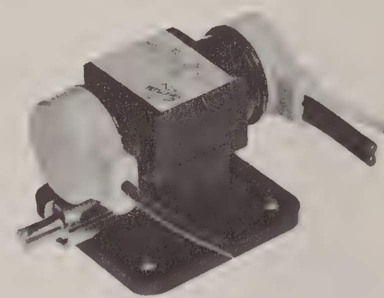


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1118B

X BAND REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	10.7 to 11.2 Gc
Mechanically tunable	500 Mc
Power output	30 mW
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	30 Vdc
Cathode current	25 mAdc
Repeller voltage	−100 Vdc
Modulation sensitivity	2.5 Mc/V
Heater voltage	6.3 V (ac or dc)±5%
Heater current	1.0 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	425 Vdc
Cathode current	45 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	4½ oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 mc

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.5 in.
Length	2.5 in.

APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

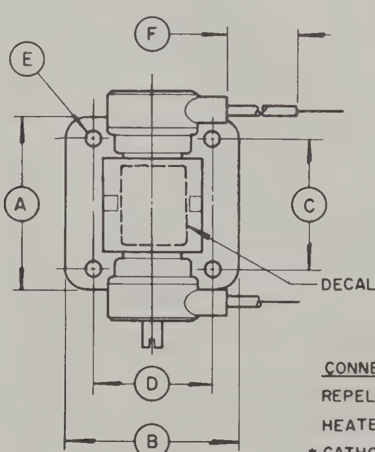
Resonator: The resonator of the X1118B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1118B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1118B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

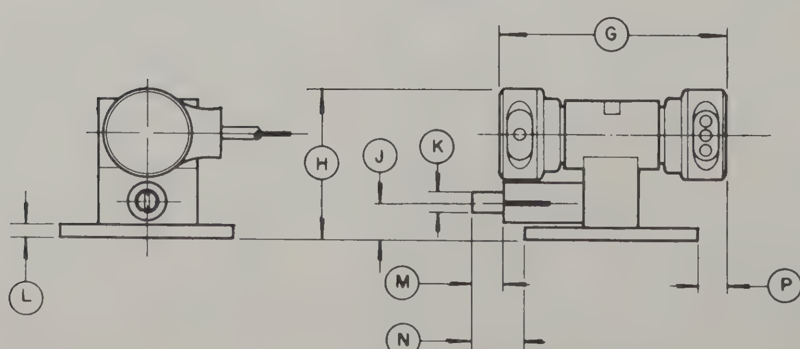
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.400	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	

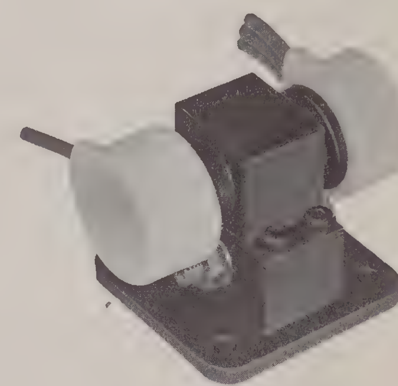


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1123

KU BAND REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency setting	13.395 Gc
Mechanically trimmable	±50 Mc
Power output	20 mW
Electronic tuning range (3 db bandwidth)	30 Mc
Resonator voltage	300 Vdc
Cathode current	30 mAdc max.
Repeller voltage	−80 to −100 Vdc
Modulation sensitivity	3.0 Mc/V max.
Heater voltage	6.3 V (ac or dc)
Heater current	0.8 A max.
Mode	5¾
VSWR of load	1.2:1 max.
Temperature coefficient	0 to −200 Kc/°C
Warm-up time	20 sec
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	55 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-91/U waveguide flange
Cooling required	conduction
Net weight	5 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−55 to +125 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.3 in.
Length	2.1 in.

APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

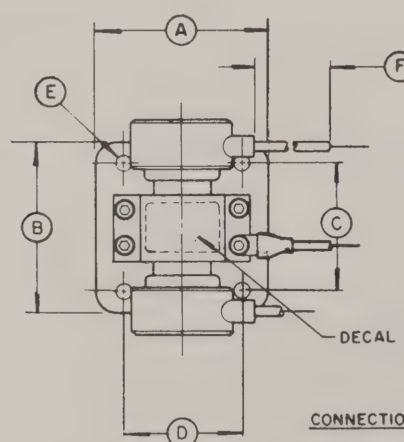
Resonator: The resonator of the X1123 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1123 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: In the X1123 a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

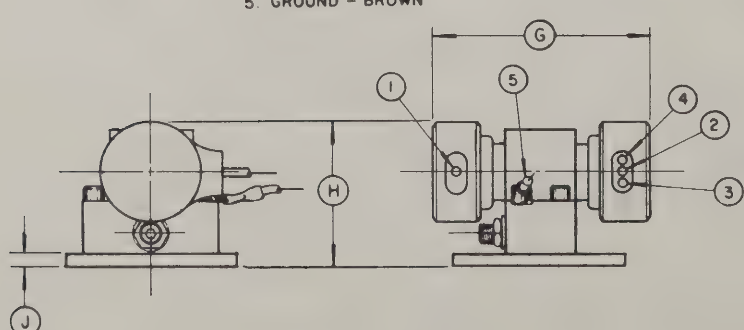


DIMENSIONS IN INCHES

REF.	DIMENSIONAL DATA MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER – GREY
2. HEATER – YELLOW
3. CATHODE – GREEN
4. HEATER CATHODE – WHITE
5. GROUND – BROWN

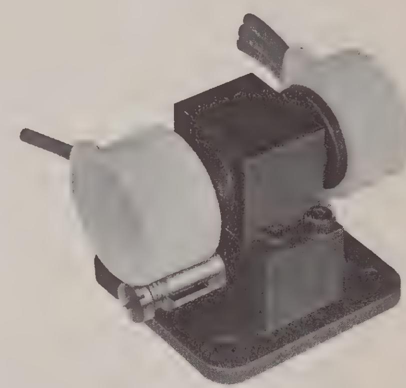


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1126

KU BAND REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	16.0 to 17.0 Gc
Mechanically tunable	1000 Mc
Power output	20 mW
Electronic tuning range (3 db bandwidth)	50 Mc
Resonator voltage	300 Vdc
Cathode current	30 mAdc max.
Repeller voltage	−80 to −100 Vdc
Modulation sensitivity	5.0 Mc/V max.
Heater voltage	6.3 V [redacted] (ac or dc) ±5%
Heater current	1.3 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	20 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	55 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-91/U wave-guide flange
Cooling required	conduction
Net weight	5 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40 G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.3 in.
Length	2.1 in.

APPLICATION

NOTE: All voltages referred to cathode.

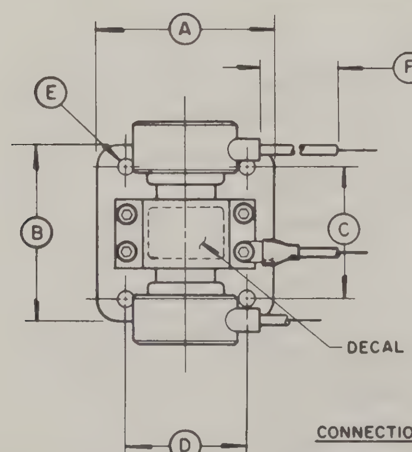
Cooling: The X1126 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1126 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1126 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

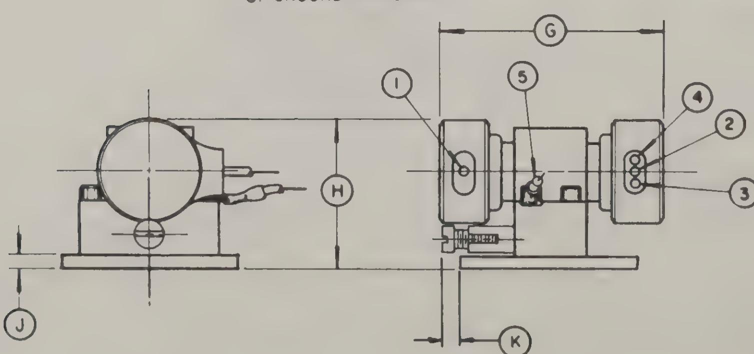


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.700	
H		1.400	
J			.125
K		.437	

CONNECTIONS

1. REPELLER – GREY
2. HEATER – YELLOW
3. CATHODE – GREEN
4. HEATER CATHODE – WHITE
5. GROUND – BROWN

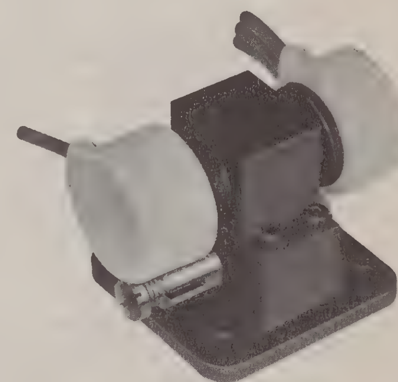


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1126B

KU BAND REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	16.5 to 17.2 Gc
Mechanically tunable	700 Mc
Power output	20 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	300 Vdc
Cathode current	30 mAdc max.
Repeller voltage	−40 to −150 Vdc
Modulation sensitivity	1.3 to 3.5 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	5¾
VSWR of load	1.2:1 max.
Temperature coefficient	−200 to −400 Kc/°C
Warm-up time	20 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	55 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-91/U wave-guide flange
Cooling required	conduction
Net weight	5 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−55 to +120 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40 G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.3 in.
Length	2.1 in.

APPLICATION

NOTE: All voltages referred to cathode.

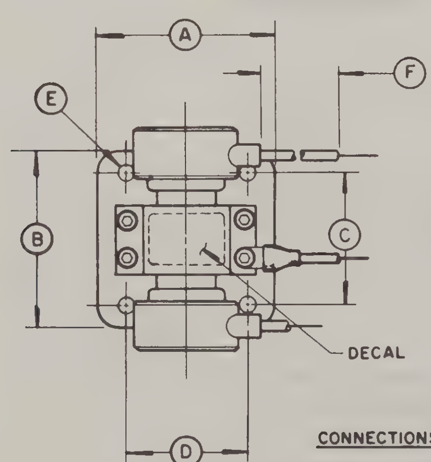
Cooling: The X1126B may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1126B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1126B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

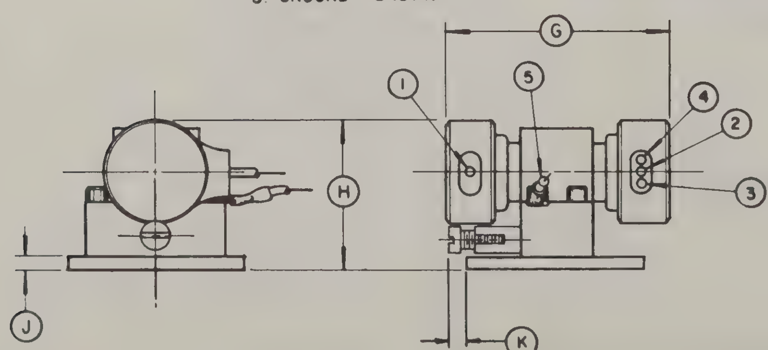


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.700	
H		1.400	
J			.125
K		.437	

CONNECTIONS

1. REPELLER – GREY
2. HEATER - YELLOW
3. CATHODE – GREEN
4. HEATER CATHODE – WHITE
5. GROUND – BROWN



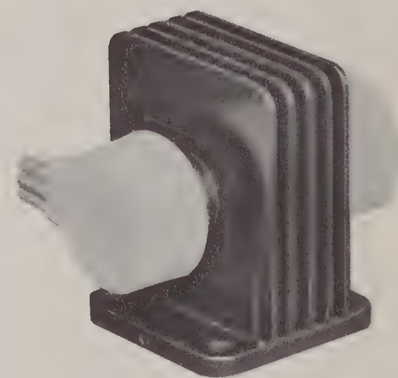
Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1115

KU BAND REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	12.2 to 12.7 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	−300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

(EFFECTIVE 4-1-64)

APPLICATION

NOTE: All voltages referred to cathode.

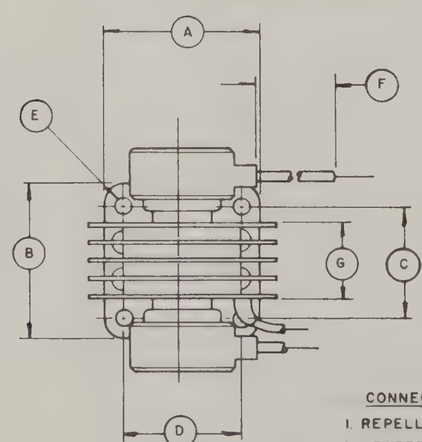
Cooling: The X1115 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1115 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1115 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

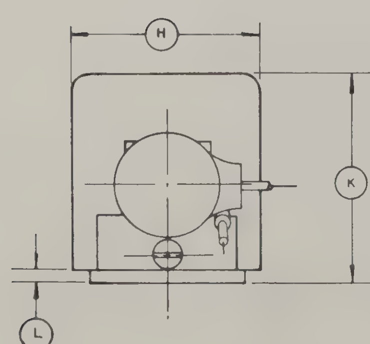


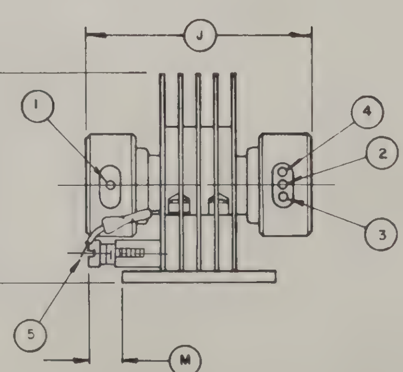
DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	.148 D	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



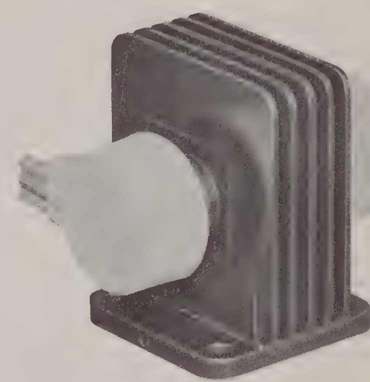


EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X1116

X BAND
REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	11.7 to 12.2 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	–300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	–50 to –1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	–50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

APPLICATION

NOTE: All voltages referred to cathode.

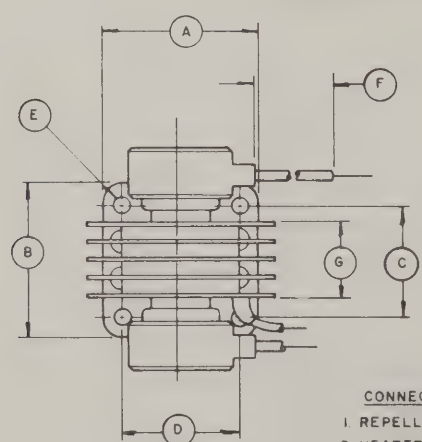
Cooling: The X1116 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1116 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1116 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

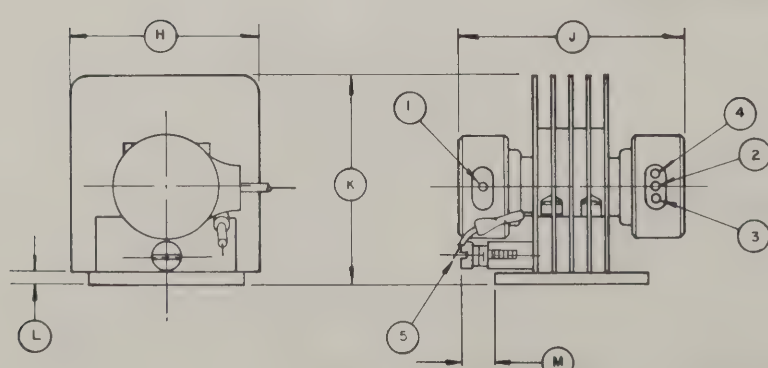
Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	.148 D	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	



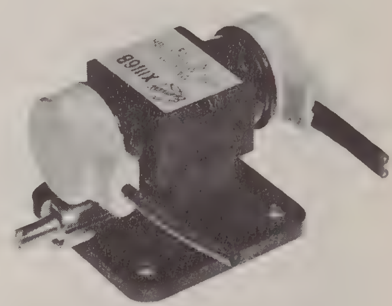
EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X1116B

X BAND REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.7 to 12.2 Gc
Mechanically tunable	500 Mc
Power output	30 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	300 Vdc
Cathode current	25 mAdc
Repeller voltage	−100 Vdc
Modulation sensitivity	2.5 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	425 Vdc
Cathode current	45 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −400 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	4½ oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.5 in.
Length	2.5 in.

APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

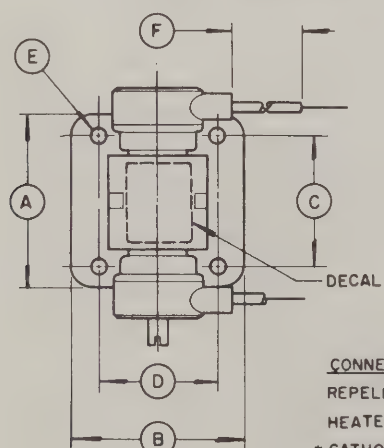
Resonator: The resonator of the X1116B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1116B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1116B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

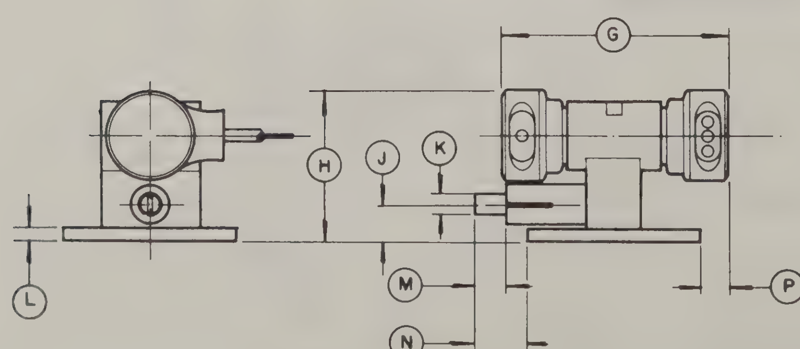
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.400	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	



Eimac®

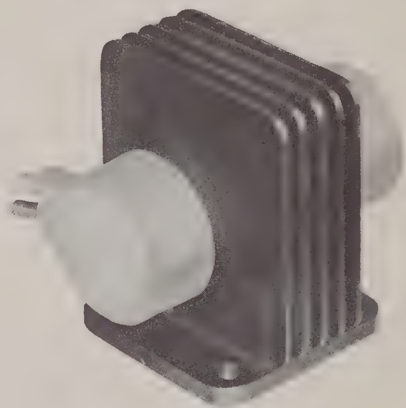
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1117

X BAND REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.2 to 11.7 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	–300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	–50 to –1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	–50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

(EFFECTIVE 4-1-64) PRINTED IN U.S.A.

APPLICATION

NOTE: All voltages referred to cathode.

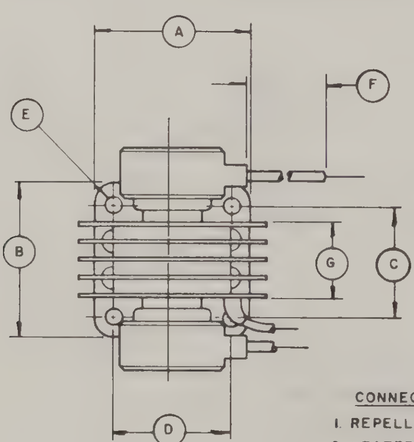
Cooling: The X1117 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1117 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1117 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

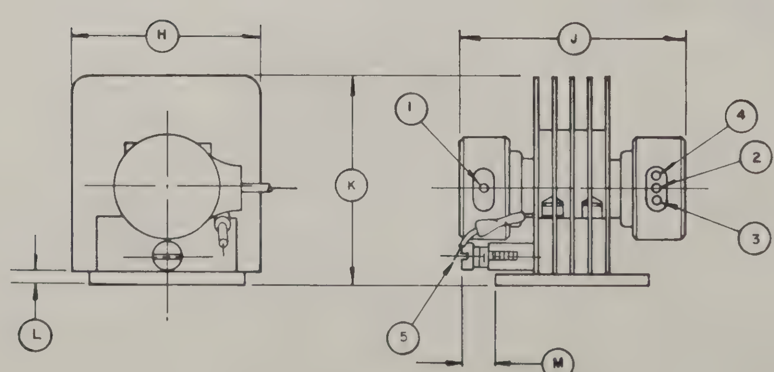


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	.148 D	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



Eimac

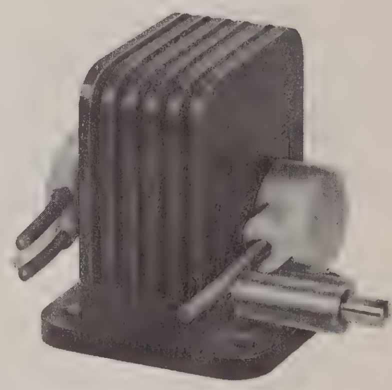
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1117A

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.2 to 11.7 Gc
Mechanically tunable	500 Mc
Power output	100 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	400 Vdc
Cathode current	40 mAdc
Repeller voltage	—150 Vdc
Modulation sensitivity	2.0 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	4¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	60 mA
Repeller voltage:	
Negative with respect to cathode	—25 to —500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	—50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.8 in.
Width	1.5 in.
Length	2.5 in.

APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

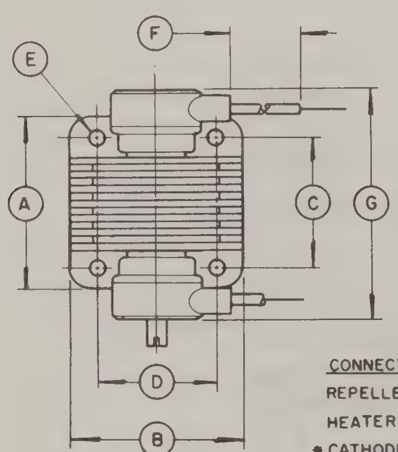
Resonator: The resonator of the X1117A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1117A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1117A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

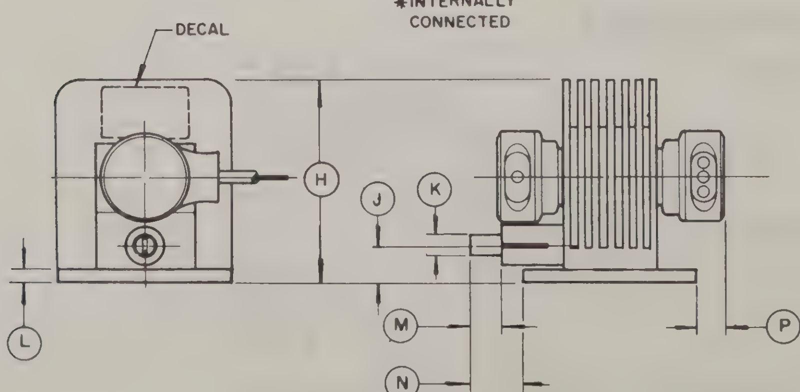
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
* INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.800	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	

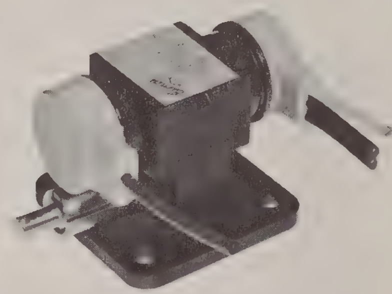


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1117B

X BAND
REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	11.2 to 11.7 Gc
Mechanically tunable	500 Mc
Power output	30 mW
Electronic tuning range (3 db bandwidth)	60 Mc
Resonator voltage	300 Vdc
Cathode current	25 mAdc
Repeller voltage	−100 Vdc
Modulation sensitivity	2.5 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	425 Vdc
Cathode current	45 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −400 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	4½ oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.5 in.
Length	2.5 in.

APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

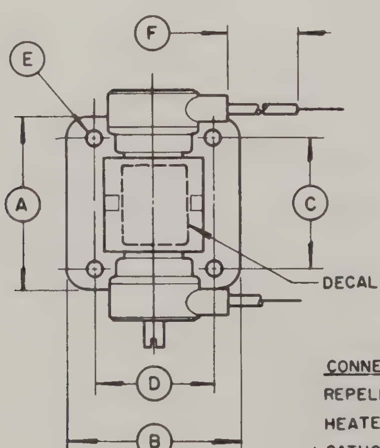
Resonator: The resonator of the X1117B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1117B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1117B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

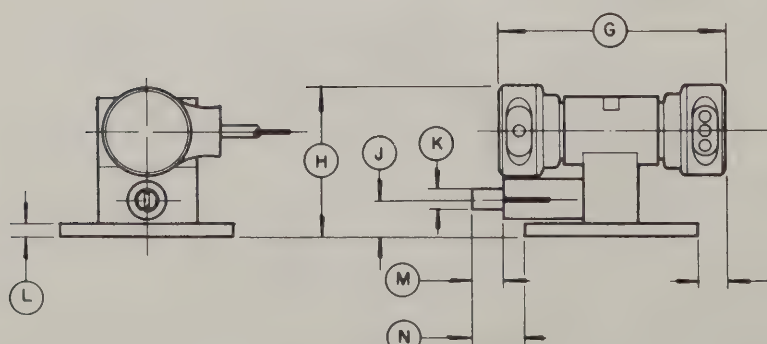
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.400	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	



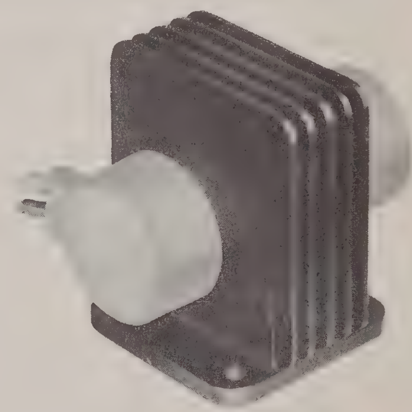
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1118

X BAND REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	10.7 to 11.2 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	–300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
Life	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	–50 to –1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	–50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

APPLICATION

NOTE: All voltages referred to cathode.

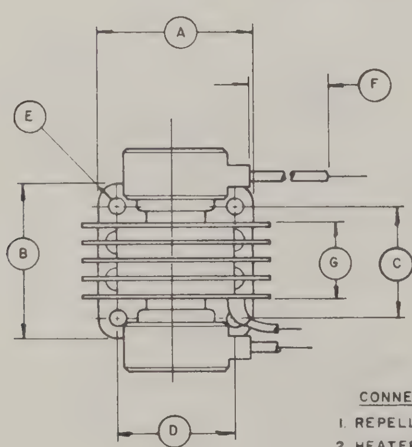
Cooling: The X1118 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1118 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1118 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

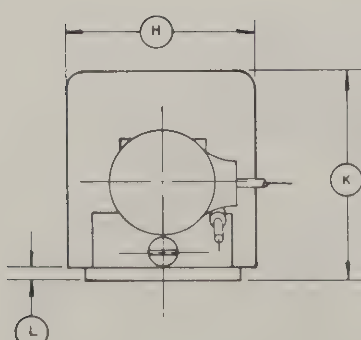
Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

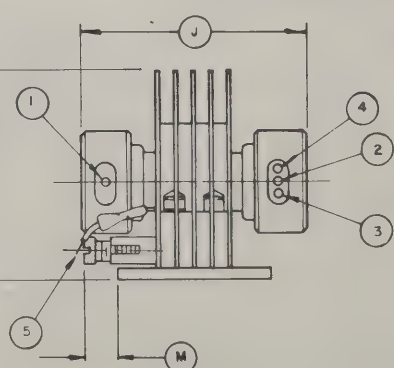


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	148D.	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN





EITEL-McCULLOUGH, INC.

1K75CLA

REFLEX

KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting - -	4.300 to 4.375 Gc
Power Output - - -	240 mW
Electronic Tuning Range (3 db bandwidth) -	50 Mc
Resonator Voltage - -	550 Vdc
Cathode Current - -	38 mA
Repeller Voltage - -	—93 Vdc
Modulation Sensitivity -	1.0 to 2.0 Mc/V
Heater Voltage - - -	6.3 V(ac or dc)±5%
Heater Current - - -	1.5 A max
Mode - - - - - -	4-3/4
VSWR of Load - - -	1.05:1
Temperature Coefficient	±150 Kc/°C max
Warm-up Time - - -	120 seconds max
[redacted] - - - - - - -	[redacted]

*MAXIMUM RATINGS

Resonator Voltage - - - - - -	900 Vdc
Cathode Current - - - - - -	85 mA
Repeller Voltage (negative with respect to the cathode) -	—50 to —500 Vdc

*Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position - - - -	Any
Electrical Connection - - -	Flexible Leads
RF Output Coupling - - - -	1/2 height, RG 49 A/U waveguide flange
Cooling Required - - - -	Conduction
Net Weight - - - - - -	10 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range - - - -	—55 to +90° C
Altitude - - - - - - - -	50,000 ft. max
Vibration - - - - - - -	10 G, 20-2000 cps
Shock - - - - - - - - -	30 G, 11 ms

OUTLINE DIMENSIONS

Height - - - - - - - - -	2-1/32 inches
Width - - - - - - - - - -	2-49/64 inches
Length - - - - - - - - -	1-9/16 inches

APPLICATION NOTES

NOTE: All voltages referred to the cathode.

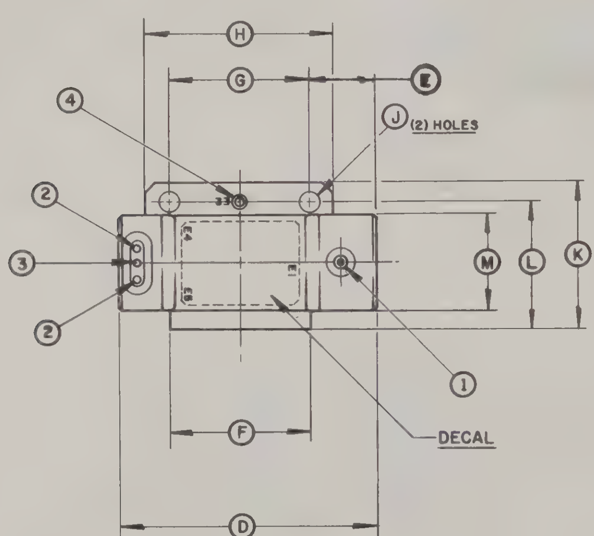
COOLING: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade.

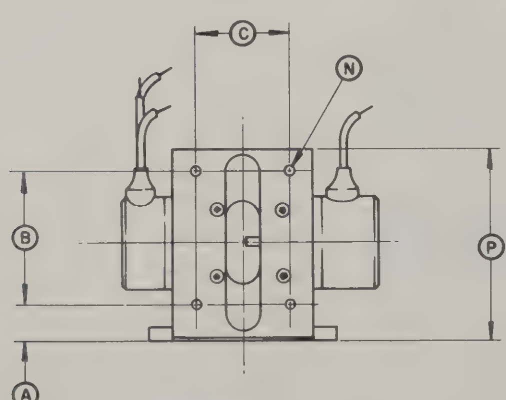
RESONATOR: The resonator of the 1K75C series tube is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

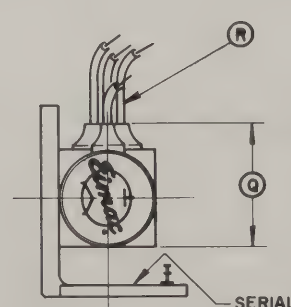
CATHODE: The heater voltage should be maintained with $\pm$ 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed $\pm$45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	.365	.385	
B	1.396	1.416	
C	.990	1.010	
D		2.730	
E		.684	
F		1.520	
G	1.495	1.505	
H		1.968	
J	.215 DIA.	.225 DIA.	
K		1.593	
L	1.339	1.349	
M		1.010	
N	#6-32 UNC-2B (4) HOLES		
P		2.030	
Q		1.345	
R	18" MIN. INSULATION		





CONNECTIONS:
1. REPELLER — RED
2. HEATER — WHITE
3. CATHODE — BLACK
4. RESONATOR — TERMINAL

FINISH:
TUBE BODY — PAINTED
TUBE FLANGE — GOLD PLATED

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X1079

C-BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Range	any specified 400 Mc position of the 4.0 to 6.0 Gc band
Mechanically Tunable	400 Mc
Power Output	200 mW
Electronic Tuning Range (3 db bandwidth)	45 Mc
Resonator Voltage	550 Vdc
Cathode Current	38 mA
Repeller Voltage	−60 to −150 Vdc
Modulation Sensitivity	.8 to 2.0 Mc/V
Heater Voltage	6.3 V(ac or dc)−5%
Heater Current	1.5 A max
Mode	4-3/4
VSWR of Load	1.05 to 1
Temperature Coefficient	±75 Kc/°C
Warm-up Time	120 sec max
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator Voltage	900 Vdc
Cathode Current	85 mA
Repeller Voltage (negative with respect to the cathode)	−50 to −500 Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	any
Electrical Connection	Flexible Leads
RF Output Coupling	1/2 height RG 49 a/u waveguide flange
Cooling Required	Conduction
Net Weight	12 ounces
Shipping Weight (approximate)	4-1/2 pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range	−55 to +90° C
Altitude	50,000 ft.
Vibration	10 G, 20-1500 cps
Shock	30 G, 11 ms

OUTLINE DIMENSIONS

Height	3 inches
Width	2-3/4 inches
Length	2-3/4 inches

APPLICATION NOTES

Note: All voltages are referred to the cathode.

COOLING: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade.

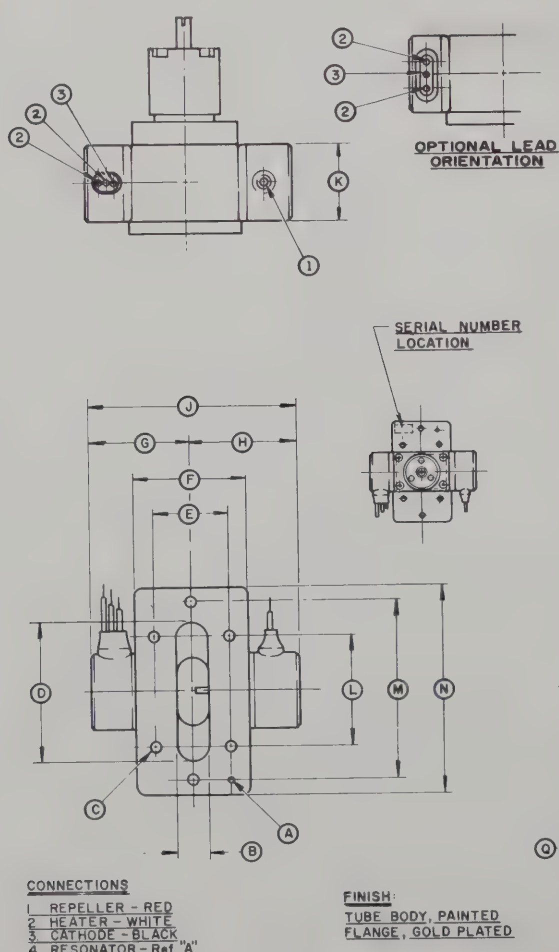
RESONATOR: The resonator of the X1079 is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

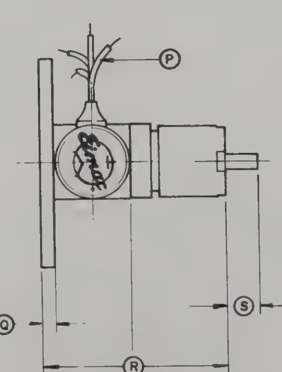
The Eimac X-1079 is a ruggedized, ceramic and metal reflex klystron which provides a minimum output power of 200 milliwatts over any specified 400 Mc portion of the 4 - 6 Gc band. This low-noise tube is conservatively designed to operate for 5000 hours.

The X-1079 can also be provided with an integral ferrite isolator for applications demanding low frequency pulling into high VSWR loads. Combining the two components into one "iso-klystron" package allows them to be matched for optimum performance and at the same time reduces the system designer's logistic problems.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4-40 UNC-2B		
B	.370	.374	
C	.185 DIA. 6 HOLES		
D	1.868	1.876	
E	.996	1.004	
F	1.495	1.505	
G		1.367	
H		1.443	
J		2.810	
K		1.010	
L	1.496	1.504	
M	2.371	2.379	
N	2.745	2.755	
P	18" MIN. INSULATION		
Q	.182	.192	
R		2.480	
S		.400	



Eimac® EITEL-McCULLOUGH, INC.

X-1095

REFLEX KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting - -	factory preset at frequency between 5.9 & 6.7 Gc
Power Output - - -	400 mW
Electronic Tuning Range (3 db bandwidth) -	100 Mc
Resonator Voltage -	600 Vdc
Cathode Current - -	45 mA
Repeller Voltage - -	−150 to −200 Vdc
Modulation Sensitivity -	2.0 to 3.0 Mc/V
Heater Voltage - -	6.3 V(ac or dc)
Heater Current - -	0.7 A
Mode - - - - - -	4-3/4
VSWR of Load - - -	1.2:1 max
Temperature Coefficient	±50 kc/°C
Warm-up Time - -	30 seconds
[redacted] - - - - - - -	[redacted]

MAXIMUM RATINGS

Resonator Voltage - - - - - - - -	700 Vdc
Cathode current - - - - - - - - -	60 mA
Repeller Voltage (negative with respect to the cathode) -	−50 to −500 Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position - -	Any
Electrical Connection -	Flexible Leads
RF Output Coupling - -	See Outline Drawing
Cooling Required - - -	Conduction + Forced Air
Net Weight - - - - -	6 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature - - - - - -	−30 to +90°C
Altitude - - - - - - -	70,000 feet max
Vibration - - - - - - -	10 G, 5 to 500 cps
Shock - - - - - - - -	100 G, 11 ms

OUTLINE DIMENSIONS

Height - - - - - - - - - -	1.42 inches
Width - - - - - - - - - -	2.00 inches
Length - - - - - - - - - -	2.45 inches

APPLICATION NOTES

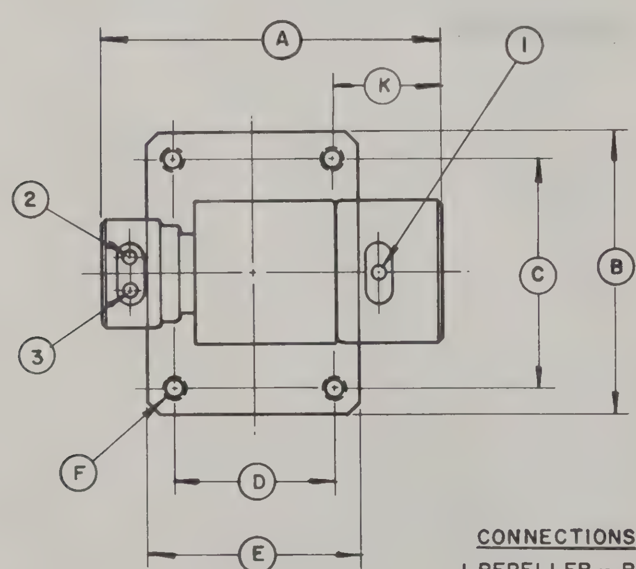
NOTE: All voltages referred to the cathode.

COOLING: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat-sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

RESONATOR: The resonator of the X1095 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

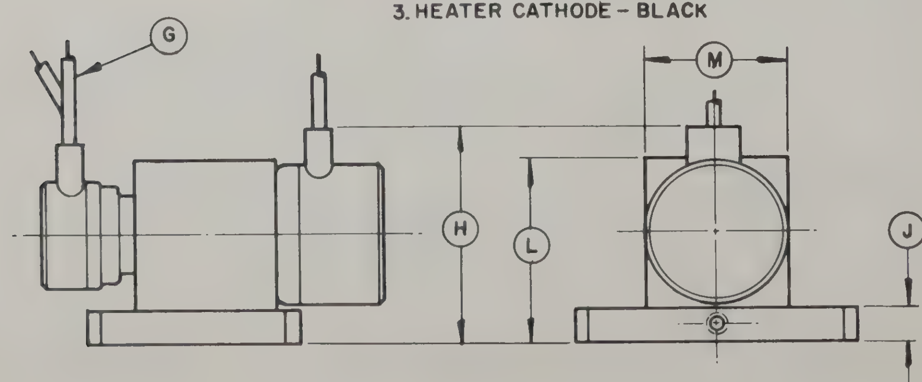
The heater and cathode of the X1095 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		2.520	
B		2.015	
C	1.620	1.630	
D	1.120	1.130	
E		1.515	
F	#8-32 TAP		
G	12±1 TYP LEAD LENGTH		
H			1.500
J		.260	
K	.800	.880	
L		1.325	
M		1.015	

CONNECTIONS

1. REPELLER – RED
2. HEATER – WHITE
3. HEATER CATHODE – BLACK



Eimac® EITEL-McCULLOUGH, INC.

X-1111

TWO-CAVITY KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting - -	13.3±.005 Gc
Power Output - - -	2.0 W min
Electronic Tuning Range (3 db bandwidth) -	10 Mc
Resonator Voltage -	2150±75 Vdc
Cathode Curent - -	15-25 mA
Modulation Sensitivity	100 kc/V
Heater Voltage - -	6.3 V(ac or dc)±5%
Heater Current - -	0-70 A
VSWR of Load - -	1.2:1
Temperature Coefficient	±100 kc/°C
Warm-up Time - -	35 seconds
[redacted] - - - - - -	[redacted]

MAXIMUM RATINGS

Resonator Voltage - - - - - - -	2500 Vdc
Cathode Current - - - - - - - - -	30 mA

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position -	Any
Electrical Connection	Flexible Leads
RF Output Coupling -	RG—91/V waveguide flange
Cooling Required - -	Conduction
Net Weight - - - -	8 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range - - -	−20 to +75°C
Altitude - - - - - -	100,000 feet max
Vibration - - - - - -	10 G, 20 to 2000 cps
Shock - - - - - - -	60 G, 11 ms

OUTLINE DIMENSIONS

Height - - - - - - - - - -	.90 inches
Width - - - - - - - - - -	1.35 inches
Length - - - - - - - - - -	2.80 inches

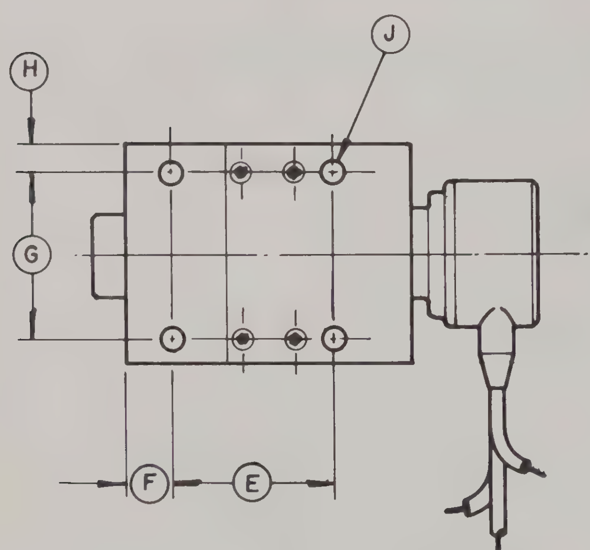
APPLICATION NOTES

1. NOTE: All voltages are referred to the cathode.

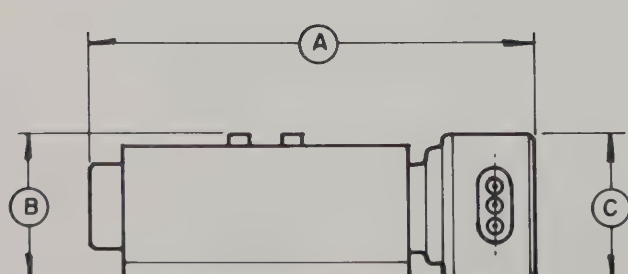
2. RESONATOR: The resonator of the X-1111 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

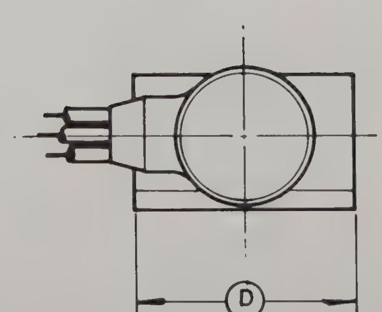
3. CATHODE: The heater voltage should be maintained with ± 5% of the rated value of 6.3 volts if variations in performance are to be mimimized and best tube life obtained.

   The heater and cathode of the X-1111 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		2.660	
B			.920
C			.905
D		1.325	
E	.946	.966	
F			.250
G	.984	1.004	
H			.159
J	.144 D	.150 D	





Eimac®

EITEL-McCULLOUGH, INC.

X-1113

TWO-CAVITY KLYSTRON

TENTATIVE DATA

ELECTRICAL PERFORMANCE

Frequency Setting - -	35 Gc
Power Output - - -	2.0 W min
Electronic Tuning Range (3 db bandwidth) -	40 Mc
Resonator Voltage -	2500±150 Vdc
Cathode Current - -	25-40 mAdc
Modulation Sensitivity	100 Kc/V.
Heater Voltage - -	6.3 V(ac or dc)±5%
Heater Current - -	2.0 A
VSWR of Load - -	1.2:1
Warm-up Time - -	35 seconds
[redacted] - - - - -	[redacted]

MAXIMUM RATINGS

Resonator Voltage - - - - - - - 3100 Vdc

Note: Damage to the tube may occur if the maximum rating is exceeded.

MECHANICAL

Operating Position -	Any
Electrical Connection	Flexible Leads
RF Output Coupling -	RG-96/V waveguide flange
Cooling Required - -	Blower or Conduction
Net Weight - - - -	17 ounces
Shipping Weight (approximate)	5 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature - - - - -	−20 to +75°C
Altitude - - - - - -	100, 000 feet max
Vibration - - - - - -	2 G, 20 to 2000 cps
Shock - - - - - - -	15 G, 11 ms

OUTLINE DIMENSIONS

Height - - - - - - - - - -	2.0 inches
Width - - - - - - - - - -	1.9 inches
Length - - - - - - - - - -	3.5 inches

APPLICATION NOTES

NOTE: All voltages are referred to the cathode.

1. RESONATOR: The resonator of the X-1113 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

2. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and cathode of the X-1113 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

X-1099

VOLTAGE TUNABLE MAGNETRON

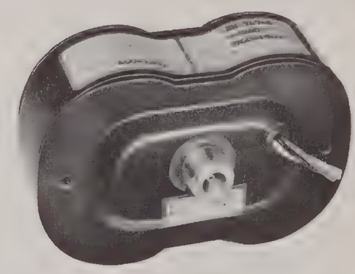
FREQUENCY 530 - 655 Mc

MINIMUM OUTPUT POWER 8 mW

Eimac®

EITEL-McCULLOUGH, INC.

TYPICAL PERFORMANCE



P-BAND OSCILLATOR

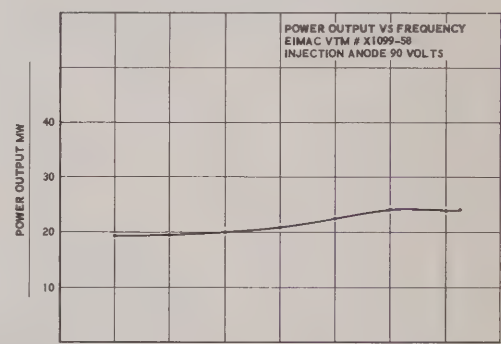
ELECTRICAL

Frequency Range	530-655 Mc
Anode Voltage	925-1150 V
Cathode Current	0.5 mA
Typical Output Power	20-25 mW
Anode FM Sensitivity	.55 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
AM Noise (See Note #5)	—75 db

*MAXIMUM RATINGS

Anode Voltage	1500 V
Cathode Current	10 mA
Injection Anode Voltage	500 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.



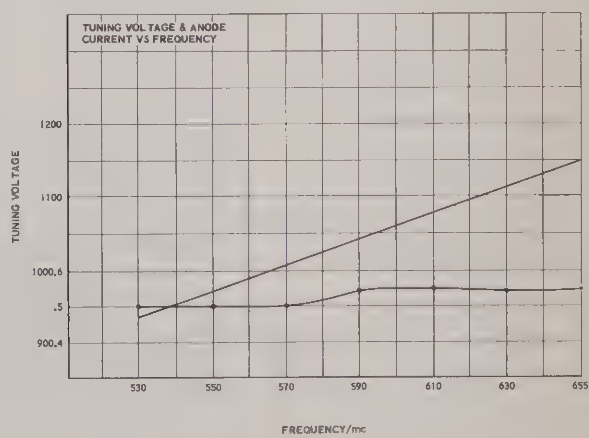
FREQUENCY MC	530	550	570	590	610	630	650	655
ANODE VOLTAGE	935	965	1000	1040	1070	1105	1145	1150
ANODE CURRENT MA	.50	.50	.50	.55	.55	.55	.55	.55
NOISE LEVEL	-77	-75.9	-77	80.2	-81.7	-79	-78.8	-79.2

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.



OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

APPLICATION NOTES

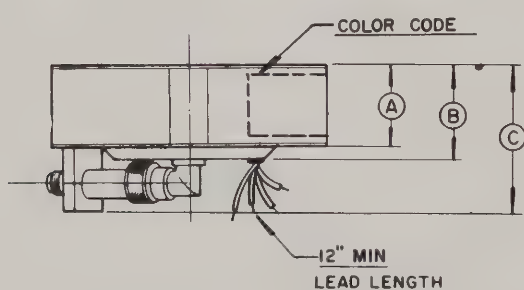
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

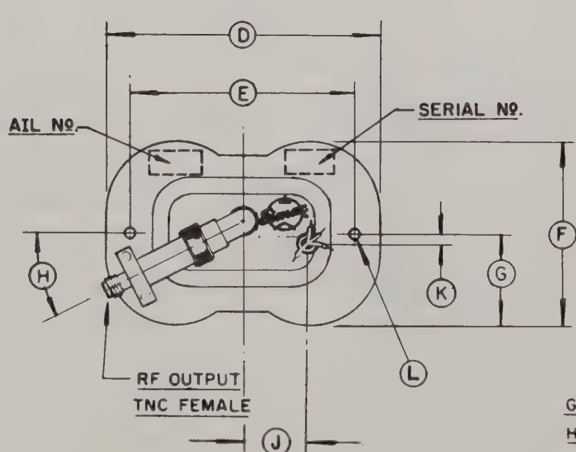
3. TEMPERATURE STABILITY: The permanent magnet for the X-1099 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1099 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 600 megacycles, the temperature/frequency coefficient is typically 48 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. AM NOISE: AM noise is defined as noise in db below the carrier using a 6 omc IF Strip with 2 Mc band pass and includes power in both side bands. Other measurement techniques can be utilized as the application requires.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN	MAX.	NOM.
A			1.375
B			1.562
C			2.500
D		4.600	
E	3.640	3.671	
F		3.100	
G			1.500
H			27°
J			1.062
K			.375
L			.173 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

Eimac

EITEL-McCULLOUGH, INC.

X-1150

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 980 - Mc 1020

MINIMUM OUTPUT POWER 40 W

TYPICAL PERFORMANCE

L-BAND OSCILLATOR

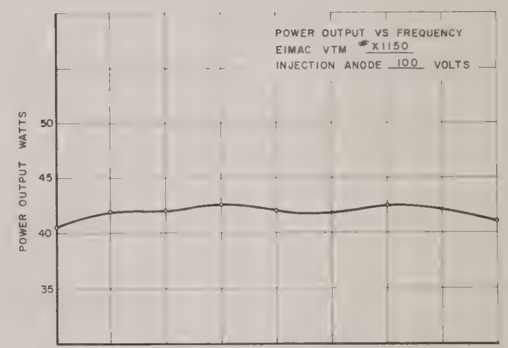
ELECTRICAL

Frequency Range - - - - - - -	980 Mc 1020
Anode Voltage - - - - - - - -	2040 V 2120
Cathode Current - - - - - - -	45-50 mA
Typical Output Power - - - - - -	45 W
Anode FM Sensitivity - - - - - -	.45 Mc/V
Injection Anode Voltage - - - - -	200 V
Injection Anode Current - - - - -	0.0 mA
Heater Voltage (AC) - - - - - -	6.3 V
Heater Current (AC) - - - - - -	0.8 A
Load Impedance - - - - - - -	50 ohms
Service - - - - - - - - - - -	cw

*MAXIMUM RATINGS

Anode Voltage - - - - - - - - - - -	2500 V
Cathode Current - - - - - - - - - -	60 mA
Injection Anode Voltage - - - - - - -	500 V
Injection Anode Current - - - - - - -	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.



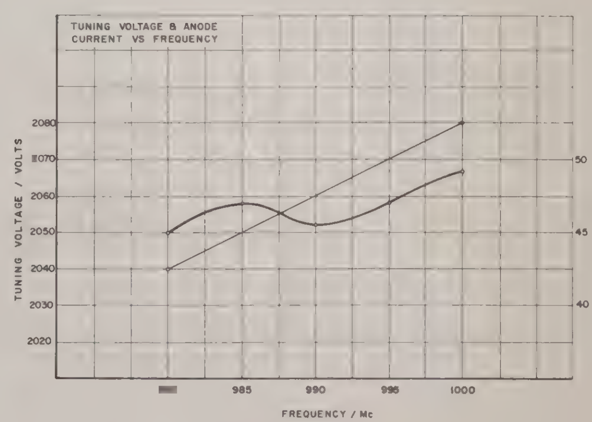
FREQUENCY MC	980	985	990	995	1000	1010	1020
ANODE VOLTAGE	2040	2047	2058	2064	2080	2100	2120
ANODE CURRENT MA	45	47	46	47	49	51	52

MECHANICAL

Operating Position - - - - -	Any
Cooling - - - - - - - - - -	Forced Air
Electrical Connection - - - -	Flexible Leads
RF Output Coupling - - - - -	Type N Jack
Weight - - - - - - - - - -	3.5 Pounds

ENVIRONMENTAL

Vibration - - - - - - - - - -	10G (to 2kc)
Shock - - - - - - - - - - -	100G (11ms)
Altitude - - - - - - - - - -	70,000 ft.



OUTLINE DIMENSIONS

Height - - - - - - - - - -	35 inches
Width - - - - - - - - - -	2.5 inches
Length - - - - - - - - - -	4.5 inches

APPLICATION NOTES

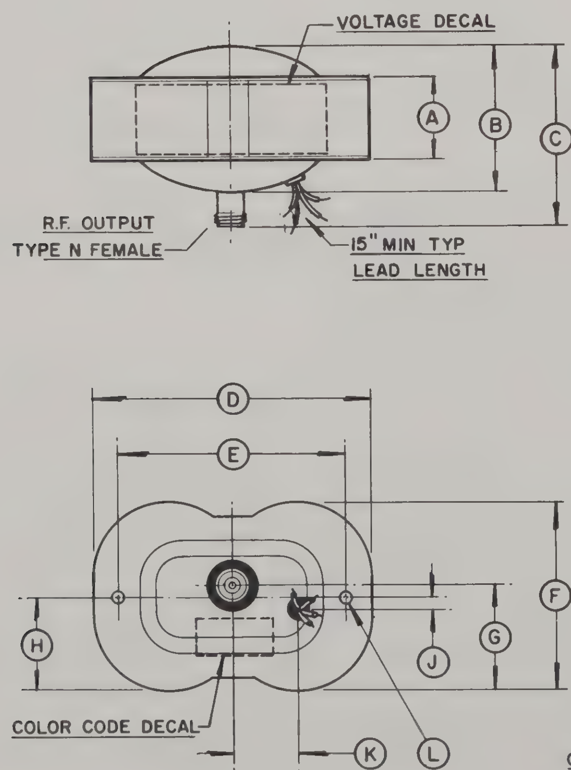
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1150 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1150 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			2.300
C			2.910
D		4.600	
E	3.640	3.671	
F		3.100	3.000
G			1.656
H			1.500
J			.375
K			1.000
L			.187 D.



CONNECTIONS
GROUND - GREEN
HEATER - WHITE
HEATER CATHODE - BLACK
INJECTION ANODE - YELLOW

DIVISION OF VARIAN
301 Industrial Way
San Carlos, California

TABLE OF CONTENTS

(Revised 10-15-76)

Printed in U.S.A.

TABLE OF CONTENTS

GENERAL

DIODES-RECTIFIERS

PLANAR TRIODES

TRIODES

TRIODES

304TL	6-1-67
450TH	12-15-65
450TL	12-15-65
592/3-200A3	6-15-66
1000T	12-15-65
1500T	5-5-70
2000T	10-15-50
5867A	11-15-64
6696A	10-15-64
6697A	10-15-64
7480	11-1-68
8873/8874/8875	6-3-73
8938	5-15-73
8963	8-1-75

TETRODES

4-65A/8165	5-1-62
4-125A/4D21	6-1-67
4-250A/5D22	5-5-70
4-400A/8438	7-20-70
4-400C/6775	4-1-71
4-500A	3-10-72
4-1000A/8166	10-30-66
4CN15A	6-1-68
4CPX250K/8590	5-1-76
4CS250R	9-1-70
4CV8000A	3-15-71
4CV20,000A	6-1-68
4CV35,000A	5-15-66
4CV50,000E	4-1-76
4CV50,000J	7-15-71
4CV100,000C/8351	2-1-68
4CV250,000A	3-1-72
4CW800B/F	11-1-73
4CW2000A/8244	6-15-71
4CW10,000A/8661	4-15-63
4CW25,000A	2-1-72
4CW50,000E	9-1-75
4CW50,000J	7-15-71
4CW100,000D	9-1-75
4CW100,000E	9-1-70
4CW250,000A	3-1-71
4CX125C/F	6-1-67
4CX250B/7203 & 4CX250FG/8621	8-1-74
4CX250BC/8957	1-1-74
4CX250K/8245 & 4CX250M/8246	5-1-68
4CX250R/7580W	6-16-61
4CX300A/8167	8-30-66
4CX300Y/8561	6-15-66
4CX350A/8321 & 4CX350F/8322	6-15-65
4CX350FJ/8904	9-1-71
4CX600B & 4CX600F	3-20-70
4CX600J/8809 & 4CX600JA/8921	8-15-71
4CX1000A/8168	5-1-70
4CX1000K/8352	8-20-66
4CX1500A	12-1-71
4CX1500B/8660	6-1-67
4CX3000A/8169	1-20-76
4CX5000A/8170	4-15-69
4CX5000J/8909	10-1-71
4CX5000R/8170W	5-1-76
4CX10,000D/8171	1-1-72
4CX10,000J	2-1-72
4CX15,000A/8281	12-15-73
4CX15,000J/8910	10-15-71
4CX35,000C/8349	9-1-75
4W300B/8249	11-1-73
4X150A/7034 & 7609	8-1-74
4X150G/8172	10-15-73
4X500A	1-1-64
6816,6884,7843	11-15-71
7609	see 4X150A/7034
8560A	7-15-71
8876	6-15-71
8930	12-1-73
8954	6-1-74
8959	11-1-74
X2159	7-1-73

PENTODES

5-125B/4E27A	8-15-52
5-500A	5-1-68
5CX1500A	11-15-75
5CX3000A	8-1-67
264/8576	6-5-70
290	5-5-70
8295A	1-15-73

PULSE MODULATORS

4PR60C/8252W	6-30-71
4PR65A/8187	2-15-63
4PR125A/8247	3-15-64
4PR250C/8248	9-1-70
4PR400A/8188	9-15-65
4PR1000A/8189	12-15-65
6C21	12-15-65

OTHER PRODUCTS

VS-2, 4 & 6	9-1-75
Preformed Contact Finger Stock	6-15-71
HR Heat Dissipating Connectors	12-1-65
SK-300A	4-15-69
SK-306, SK-316	3-1-76
SK-400	4-1-56
SK-406, SK-416, SK-426	12-1-73

(Cont'd)

OTHER PRODUCTS

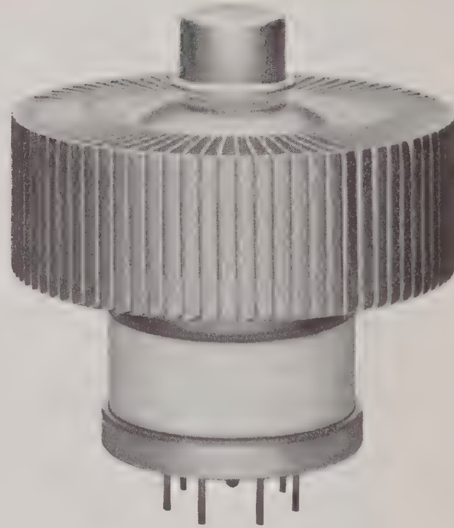
3CPX1500A7

HIGH-MU
POWER TRIODE

The EIMAC 3CPX1500A7 is a rugged ceramic/metal high-mu power triode, designed with beam-forming cathode and control-grid geometry to allow the simplicity of design and circuit advantages of a triode with the gain of a tetrode.

The 3CPX1500A7 is intended for pulse modulator or pulse regulator service, with a pulse plate current rating of 50 amperes, and a voltage holdoff rating of 10,000 volts in air, with forced-air cooling of the anode, or 15,000 volts when immersed in a suitable dielectric liquid which is also used for tube cooling.

An Air-System Socket (EIMAC SK-2200) and an Air Chimney (EIMAC SK-2216) are available for those applications requiring forced-air cooling.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	5.5 ± 0.25 V
Current, at 5.5 volts	11.2 A
Transconductance (Average, with I_b = 1.0 Adc)	55,000 μmhos
Amplification Factor (Average)	200
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	38.5 pF
Cout	0.1 pF
Cgp	10 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	4.02 in; 102 mm
Diameter	3.38 in; 86 mm
Net Weight	26 oz; 735 gm
Operating Position	Any
Maximum Operating Temperature, Ceramic/Metal Seals or Anode Core	250° C
Cooling	Forced Air or Liquid Immersion

 Printed in U.S.A.

Base	Special 7-Pin
Recommended Air-System Socket	EIMAC SK-2200
Recommended Air Chimney	EIMAC SK-2216

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 5.5 volts	10.2	12.2	A
Cathode Warmup Time	90	---	sec
Interelectrode Capacitance (grounded cathode connection) [1]			
Cin	36.0	41.0	pF
Cout	---	0.2	pF
Cgp	9.2	11.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

PULSE MODULATOR OR SWITCH TUBE SERVICE

ABSOLUTE MAXIMUM RATINGS:

	In Air	In Oil	
HEATER VOLTAGE	5.5±5%	5.5±5%	VOLTS
DC PLATE VOLTAGE	10.0	15.0	KILOVOLTS
DC GRID VOLTAGE	-200	-200	VOLTS
PEAK PLATE CURRENT[1]	50	50	AMPERES
PULSE LENGTH & DUTY [1]	See Derating Chart		
PLATE DISSIPATION[2]	1500	1500	WATTS
GRID DISSIPATION	25	25	WATTS

1. Pulse length, pulse plate current, and duty are interrelated; see Derating Chart.
2. Plate dissipation values shown are nominal; capability is dependent on cooling technique and equipment design. In all cases the ABSOLUTE MAXIMUM temperature ratings should not be exceeded, and for best life and consistent performance operation at lower temperatures is normally beneficial.
3. Approximate value.

TYPICAL OPERATION - Pulse Modulator Service

Plate Voltage	10.0	15.0	kVdc
Pulse Plate Current	40	40	a
Grid Voltage	-125	-150	Vdc
Pulse Positive Grid Voltage [3]	340	340	v
Pulse Grid Current[3]	1.5	1.5	a
Pulse Duration	2.0	2.0	μs
Duty	0.0006	0.0006	
Pulse Driving Power [3]	697	735	w
Pulse Output Power[3]	306	506	kw
Pulse Output Voltage [3]	7.68	12.68	kv

APPLICATION

MECHANICAL

MOUNTING - The 3CPX1500A7 may be operated in any position. The SK-2200 socket is designed to hold the tube and make all base contacts, and for applications where forced-air cooling is to be used, the matching air chimney, SK-2216 is available.

COOLING - The 3CPX1500A7 may be either forced-air cooled or liquid-immersion cooled in a suitable dielectric coolant fluid. The maximum temperature limit for external tube surfaces and the anode core is 250°C, but it should be noted that, where long life and consistent performance are important design factors, operation at somewhat lower temperatures is normally beneficial. The air cooling data shown will maintain tube temperatures below 225°C with 50°C cooling air.

When the tube is liquid-immersed, circulation of the dielectric fluid will normally be required and the designer is cautioned to assure sufficient tube cooling for the maximum dissipation level likely to ever be reached with some safety factor allowance.

Base-to-Anode Air Flow (sea level)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H 0
500	7.5	0.10
1000	22.5	0.20
1500	35	0.41
Base-to-Anode Air Flow (10,000 ft.)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H 0
500	11.0	0.15
1000	32.5	0.29
1500	51	0.60

Note: 1) Tube mounted in SK-2200 Socket with SK-2216 Chimney.
2) An allowance of 25 watts has been made for grid dissipation and 50 watts for filament power.

ELECTRICAL

FILAMENT/CATHODE OPERATION - Pulse current capability of the 3CPX1500A7 is dependent on cathode temperature, which in turn is dependent on heater voltage. When the full rated (ib = 50 amperes maximum) anode current is required, the heater voltage should be operated at 5.5 volts and not deviate from this nominal value by more than plus or minus five percent. When a lower value of anode current (ib = 24 amperes maximum) is adequate for the application, the heater voltage should be reduced to 5.0 volts, plus or minus five percent, and tube life expectancy will be greatly improved. In cases where better life expectancy and consistent performance are factors, regulation to better than five percent will normally be beneficial at either heater voltage level. Voltage should be measured with a know accurate rms-responding meter.

ANODE CURRENT - For pulse service, either as a switch tube or modulator, or for voltage regulator applications, an anode current (during the pulse) of up to 50 amperes is available, with Ef = 5.5 volts, or up to 24 amperes with Ef = 5.0 volts. Peak current capability, pulse length, and duty factor are interrelated and the PULSE DERATING DATA should be consulted. For pure dc service, the anode current should be limited to 1.0 ampere.

HIGH VOLTAGE - For air operation, anode voltage should not exceed 10 kVdc at sea level. This value allows some safety factor, but does assume a clean tube with no buildup of dirt or grime across the insulating ceramic. At higher altitudes a reduction in voltage may be required to preclude the possibility of external tube flashover. When the tube is immersed in a liquid dielectric coolant with suitable insulating properties the allowable anode voltage is 15 kVdc at any altitude.

The operating voltages for this tube must be considered as potentially lethal and the equipment must be designed properly and operating precautions must be followed. The equipment must include safety enclosures for the high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors or covers are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

PLATE SURGE-LIMITING IMPEDANCE - Tubes such as the EIMAC 3CPX1500A7 are built with closely spaced electrodes. This results in high voltage gradients even at normal operating voltages. A high-energy arcover between electrodes may be destructive, and therefore a series impedance in the anode lead is recommended, or the anode supply should be designed so that it has sufficient self impedance to limit the short-circuit current to 10 times the maximum pulse-current rating. Normal overload protection techniques should also be used in the anode circuit to prevent tube damage in the event of a fault condition.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than about 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 3CPX-1500A7, operating at its rated voltages and currents, is a potential X-ray hazard, with only limited shielding afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

GRID OPERATION - The maximum rated dc grid bias voltage for the 3CPX1500A7 is -200 Vdc and the maximum grid dissipation rating is 25 watts. In normal applications the grid dissipation will not approach the maximum rating.

The circuit designer should be aware that grid secondary emission effects typically occur with a tube of this size and must be considered. This effect has to do with tube geometry, the metals used in such grid structures and operating potentials. The CONSTANT CURRENT CHARACTERISTICS plots (see Page 7 and 8) show both positive and negative (secondary) grid current flow as being typical.

A driver stage which works into such a non-linear load normally must be designed in such a manner as to tolerate this condition, such as swamping the drivers so that the change in load due to forward or reverse grid currents is a small persentage of the total load the driver works into.

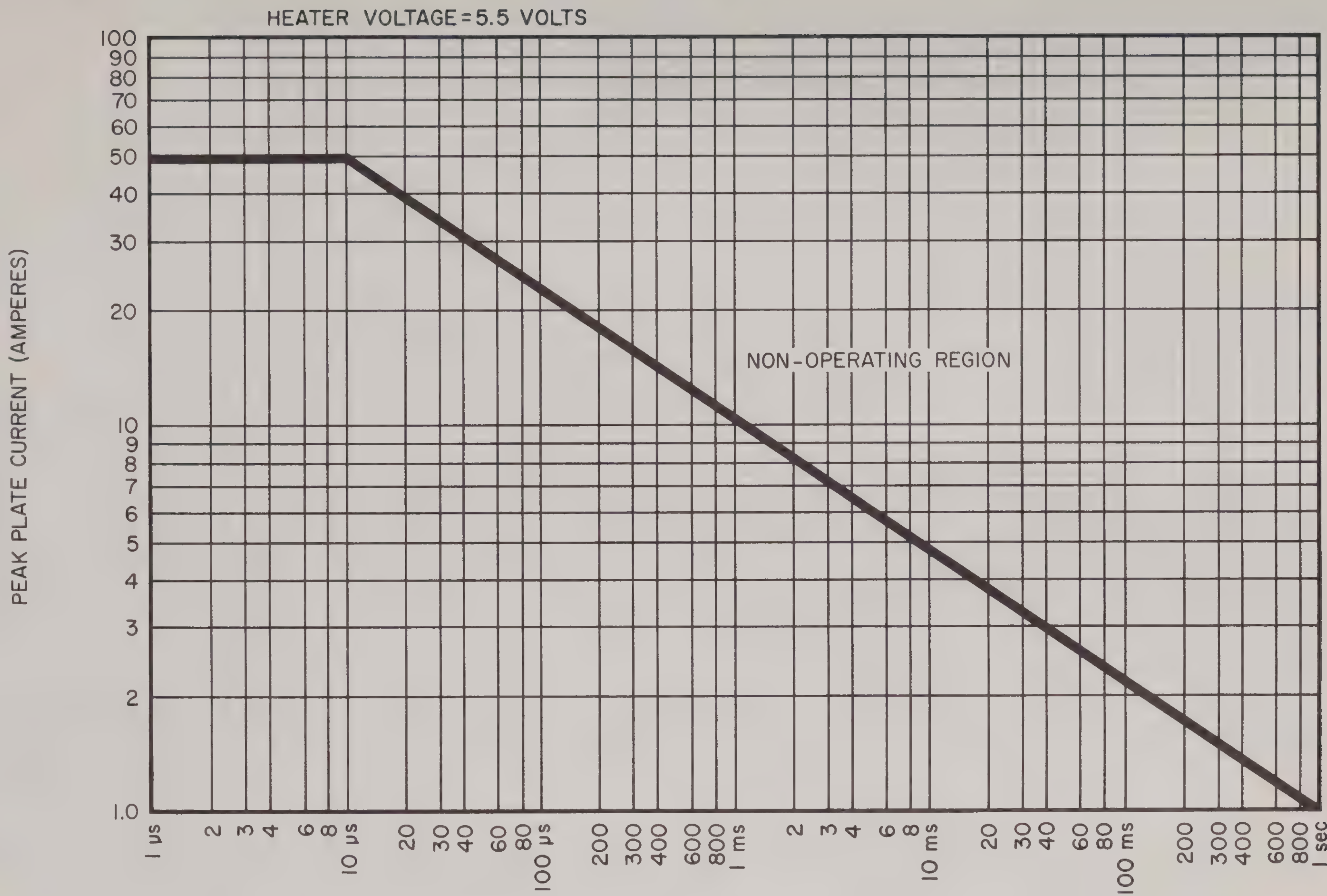
PLATE OPERATION - The anode of the 3CPX-1500A7 is nominally rated for the dissipation values shown on Page 2 depending on the type of cooling used. When the tube is immersed in a liquid dielectric coolant, with proper circulation, and (if required) provisions for dielectric fluid cooling, dissipation capability is actually limited only by tube temperature, especially in the seal areas and the anode core.

In pulse service average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. Actual dissipation may often exceed the calculated value, however, if pulse rise and fall rimes are appreciable compared to pulse duration. This occurs because long rise and fall times allow plate current to flow for longer periods in the high tube-voltage-drop region.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time; manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

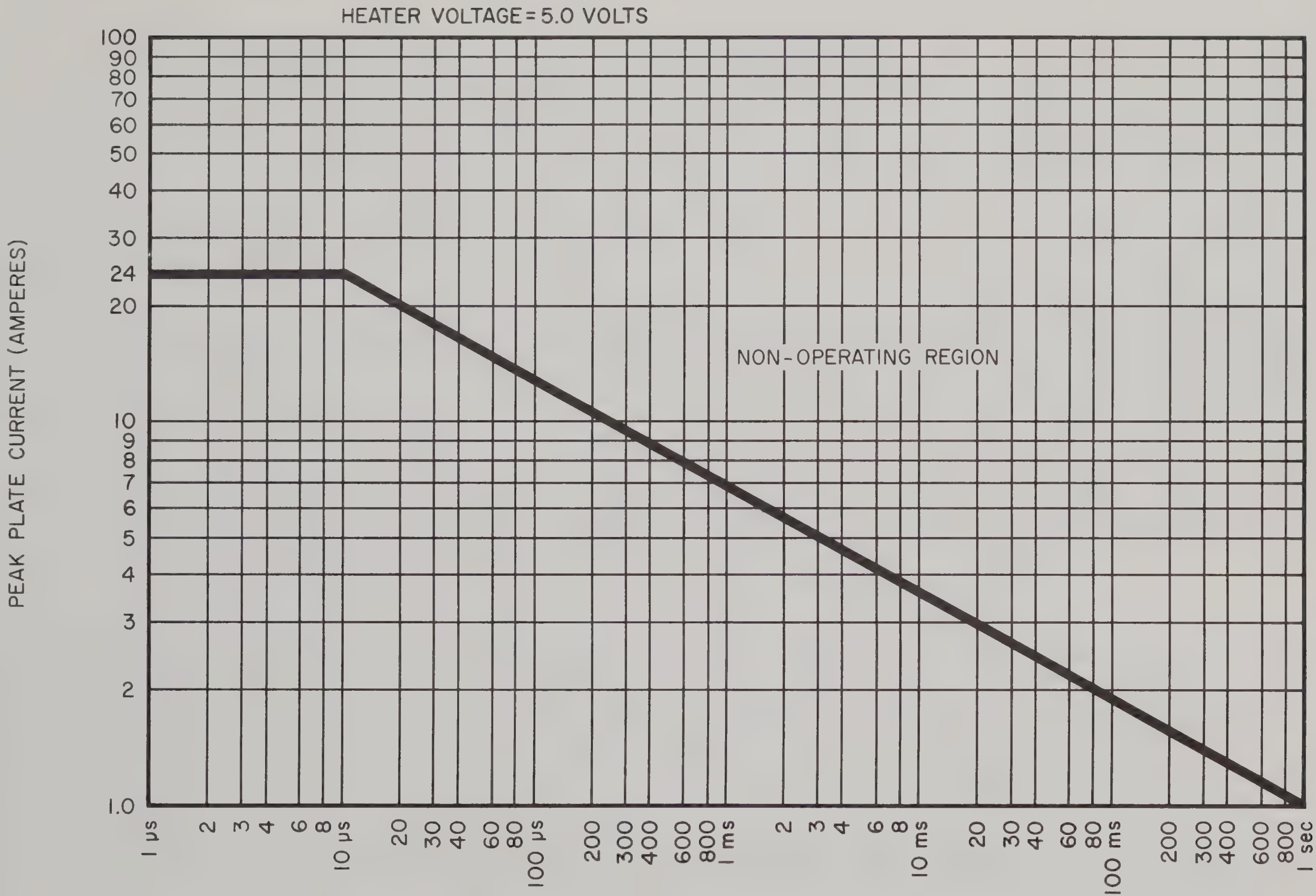
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.



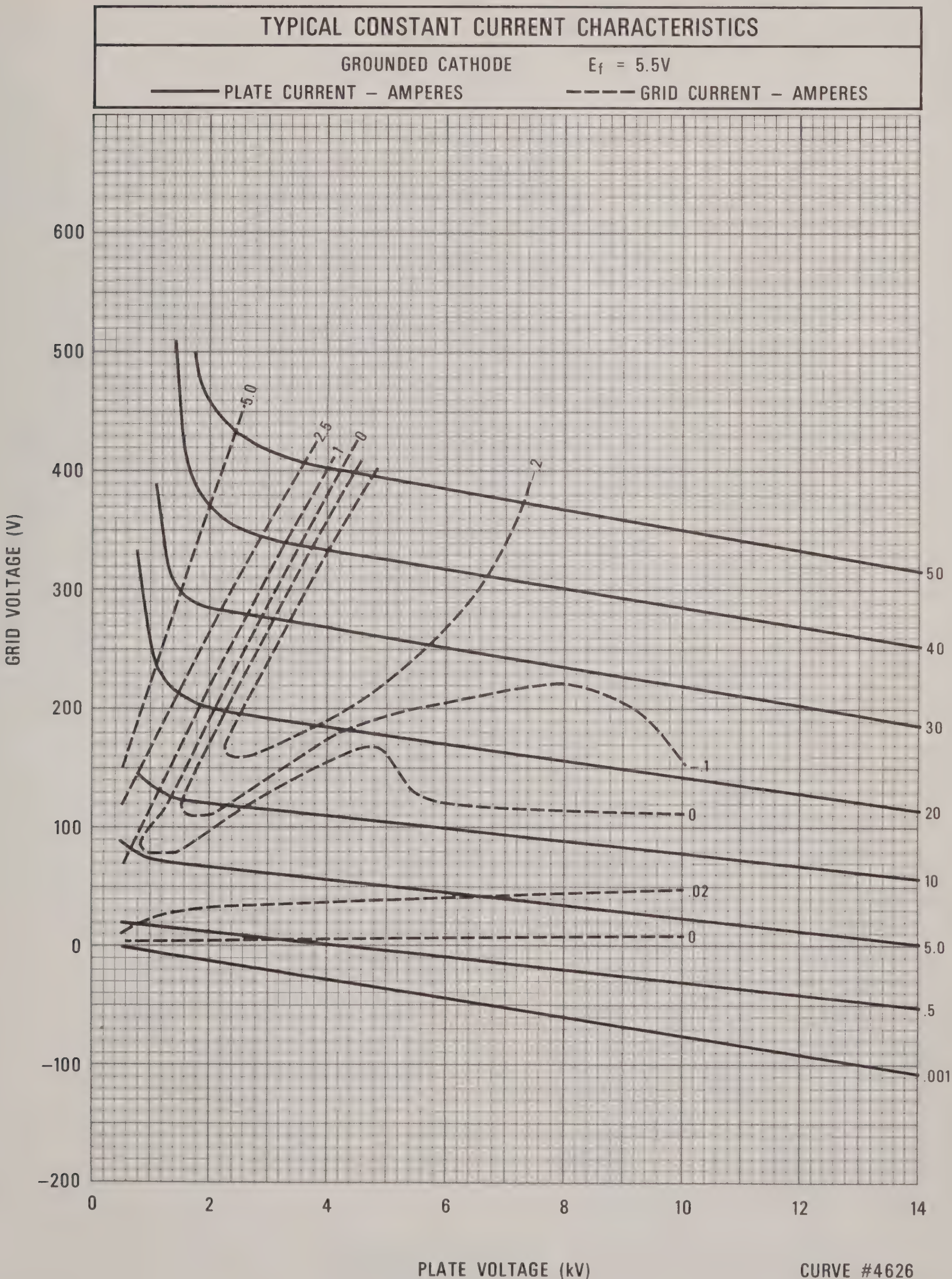
PULSE DERATING DATA, TYPE 3CPX1500A7 - PULSE MODULATOR OR REGULATOR SERVICE

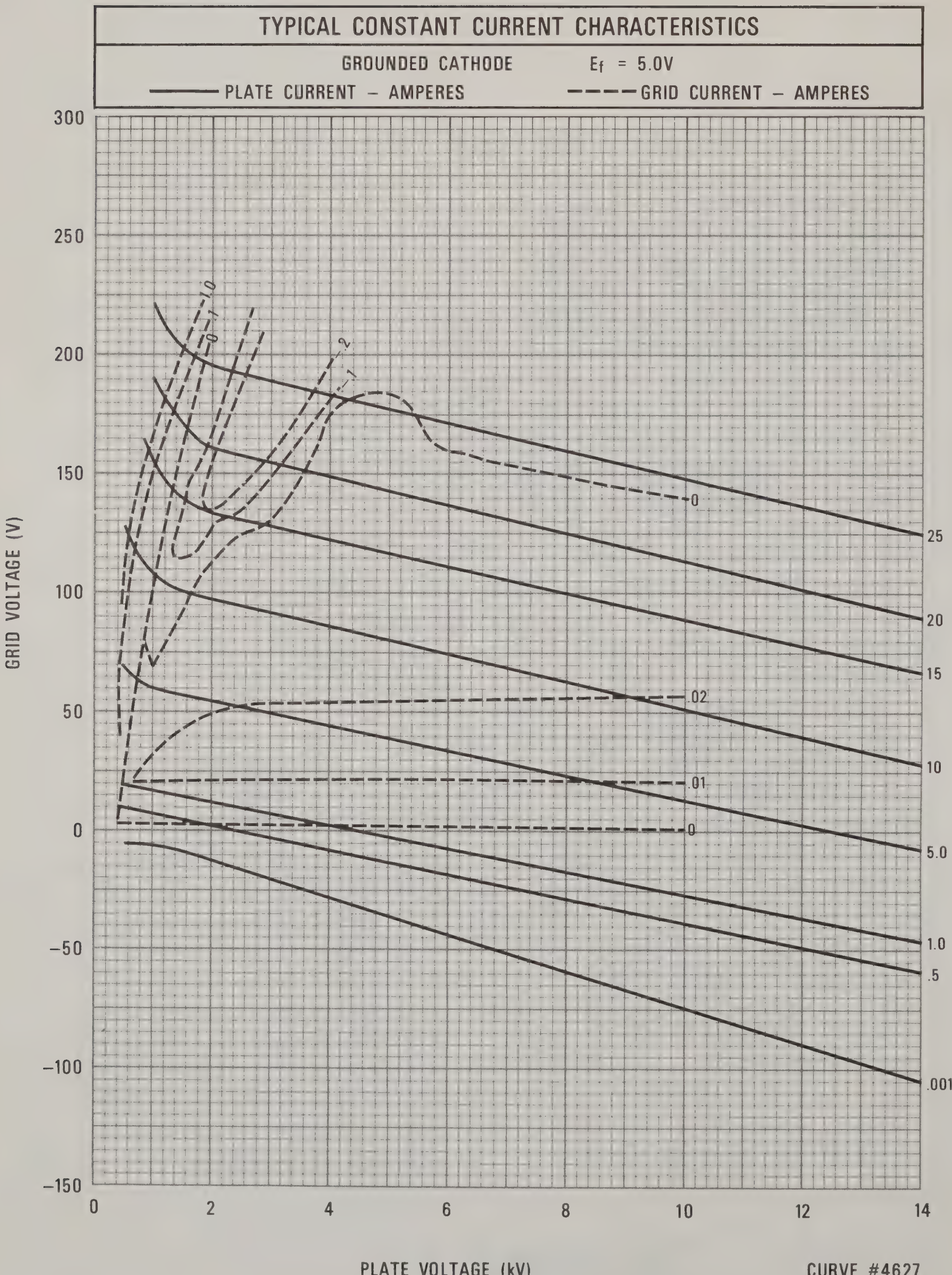
Peak (pulse) plate current capability is dependent on pulse duration (tp) and duty factor (Du). Maximum peak plate current for a given value of tp is shown. Maximum Du may then be derived from the relationship: $1.0 = ib \sqrt{Du}$



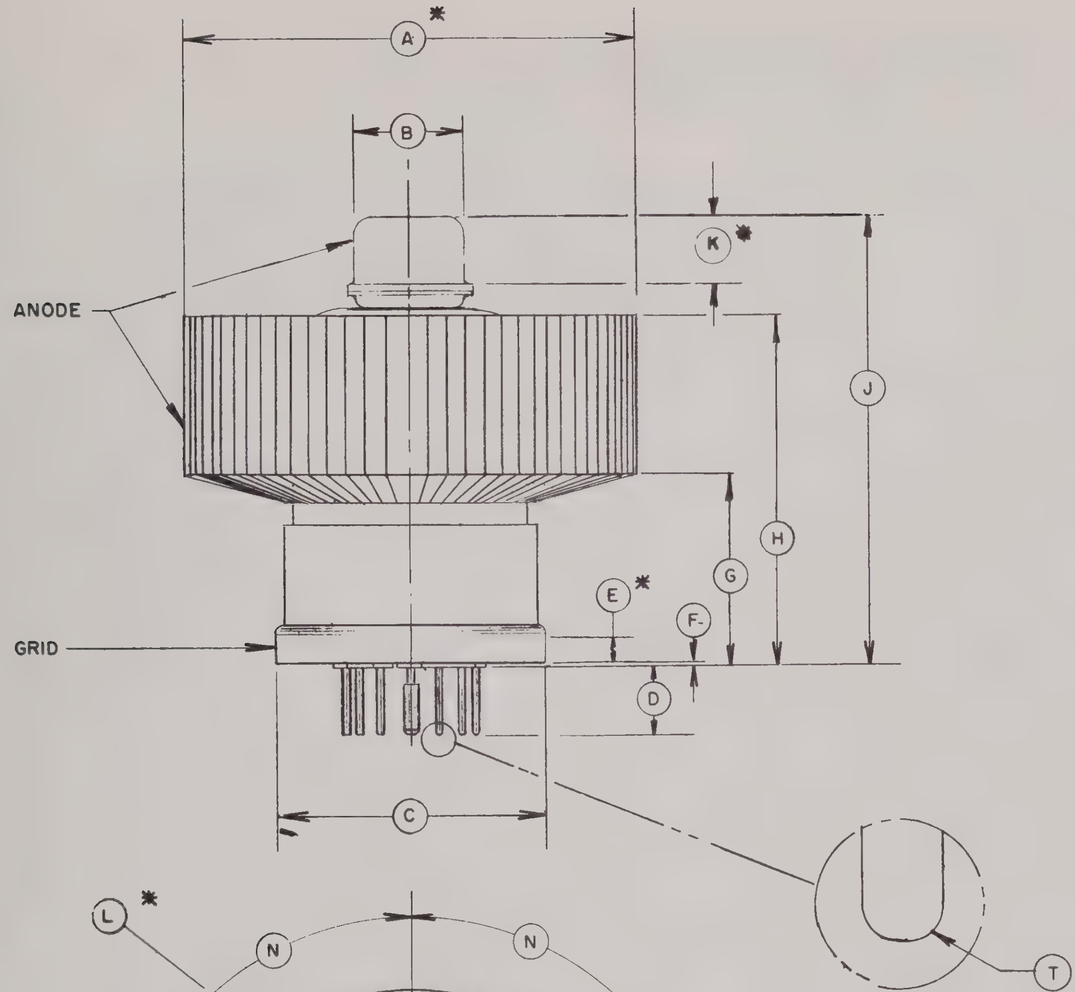
PULSE DERATING DATA, TYPE 3CPX1500A7 - PULSE MODULATOR OR REGULATOR SERVICE

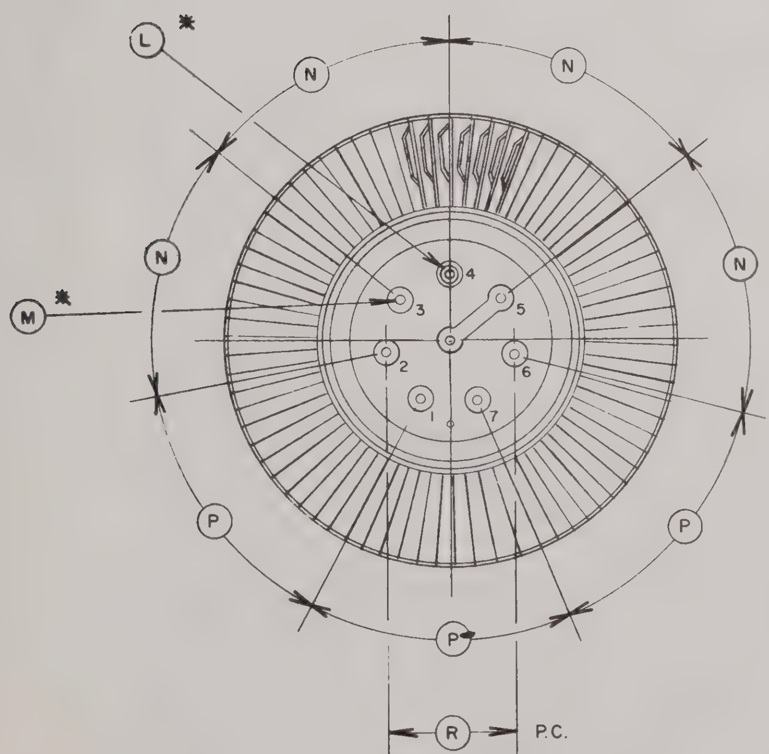
Peak (pulse) plate current capability is dependent on pulse duration (tp) and duty factor (Du). Maximum peak plate current for a given value of tp is shown. Maximum Du may then be derived from the relationship: $1.0 = ib \sqrt{Du}$


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 5.5V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
600
500
400
300
200
100
0
−100
−200
0
2
4
6
8
10
12
14
50
40
30
20
10
5.0
.5
.001
5.0
2.5
1
0
2
.1
0
.02
0
PLATE VOLTAGE (kV)
CURVE #4626



TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE Ef = 5.0V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
300
250
200
150
100
50
0
−50
−100
−150
0
2
4
6
8
10
12
14
1.0
.5
.2
.1
0
.02
.01
25
20
15
10
5.0
.001
PLATE VOLTAGE (kV)
CURVE #4627





PIN CONNECTIONS

1 - HEATER
5 - HEATER
2 - 3 - 4 - 6 - 7 CATHODE

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.350	3.380	- -	85.09	85.85	- -
B	0.810	0.820	- -	20.57	20.83	- -
C	1.995	2.015	- -	50.67	51.18	- -
D	0.438	0.562	- -	11.13	14.27	- -
E	0.235	- -	- -	5.97	- -	- -
F	0.000	0.040	- -	0.00	1.02	- -
G	1.350	1.475	- -	34.29	37.46	- -
H	2.550	2.675	- -	64.77	67.94	- -
J	3.250	3.420	- -	82.55	86.87	- -
K	0.470	0.530	- -	11.94	13.46	- -
L	0.120	0.127	- -	3.05	3.23	- -
M	0.056	0.062	- -	1.42	1.57	- -
N	- -	- -	51°	- -	- -	51°
P	- -	- -	52°	- -	- -	52°
R	- -	- -	1.000	- -	- -	25.40
T	0.020R	- -	- -	0.51 R	- -	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE
3. DIMENSION T APPLIES TO ALL BUT CENTER PIN.

3CX3000H7

HIGH-MU
AIR-COOLED
POWER TRIODE

TECHNICAL DATA

The EIMAC 3CX3000H7 is a ceramic/metal, forced-air cooled, external anode high-mu power triode for use as an amplifier, oscillator, or modulator, or in voltage regulator applications.

The tube has flexible leads on the base for the filament connections, and a flange on the grid terminal so the tube may be mounted and used with no socket.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded-grid operation is attractive, since a power gain of over 20 times can be obtained.

The anode is rated for up to 4000 watts of dissipation, with a grid dissipation rating of 225 watts.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	7.5 ± 0.37	V
Current, at 7.5 volts	50.5	A
Amplification Factor (Average)	160	

Direct Interelectrode Capacitance (grounded cathode)[2]

Cin	38	pF
Cout	0.6	pF
Cgp	24	pF

Frequency of Maximum Rating:

CW	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:

Length (excluding leads)	9.000 in; 228.60 mm
Diameter	4.250 in; 107.95 mm
Net Weight	7.0 lb; 3.2 kg
Operating Position	Vertical, base up or down

Maximum Operating Temperature:

Ceramic/Metal Seals & Anode Core	250°C
Filament Lead/Tube Base Junctions	150°C
Cooling	Forced Air
Base	See Outline

(Effective 5-15-76) Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4000	4800	4800	Vdc
Zero-Signal Plate Current[1]	0.25	0.35	0.35	Adc
Single-Tone Plate Current	2.00	1.68	2.00	Adc
Single-Tone Grid Current[1]	0.61	0.46	0.60	Adc
Peak Driving Power	420	293	410	w
Plate Dissipation	2285	2275	2775	W
Single-Tone Plate Output Power	6030	6000	7266	W
Resonant Load Impedance	1210	1720	1425	Ω
Driving Impedance	47.5	50.0	46.3	Ω

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Grid Driven, Carrier Conditions

Plate Voltage	4000	Vdc
Zero-Signal Plate Current[1]	0.25	Adc
DC Plate Current	0.74	Adc
DC Grid Current[1]	0.13	Adc
Peak rf Grid Voltage[1]	85.0	v
Peak Driving Power[1]	11.5	w
Plate Dissipation	1830	W
Single-Tone Plate Output Power	1130	W
Resonant Load Impedance	1750	Ω
Peak rf Plate Voltage	2000	v

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM, Cathode Driven
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	3500	4800	Vdc
Grid Voltage	-50	-60	Vdc
Plate Current	1.30	1.54	Adc
Grid Current[1]	0.42	0.48	Adc
Peak rf Cathode Voltage[1]	220	267	v
Calculated Driving Power[1]	310	435	W
Plate Dissipation	985	1480	W
Useful Output Power[2]	3300	5500	W

1. Approximate value.
2. Output circuit and filter loss of 10% assumed.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_2, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.
2. Per tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	Vdc
Zero-Signal Plate Current[1]	0.50	Adc
Max. Signal Plate Current	3.58	Adc
Max. Signal Grid Current[1]	0.58	Adc
Peak af Grid Voltage[2]	190	v
Peak Driving Power[3]	115	w
Max. Signal Plate Dissipation	3700	W
Plate Output Power	10,500	W
Load Resistance (plate to plate)	2720	Ω

3. Nominal drive power is one-half peak power.

VOLTAGE REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000	Vdc
DC PLATE CURRENT	4.0	Adc
PULSED PLATE CURRENT	10.0	a
PLATE DISSIPATION[1]	4,000	W
GRID DISSIPATION[1]	225	W

1 The equipment designer or user must assure that the rated dissipation values are not exceeded. In continuous operation (Class A) element dissipation is simply the product of voltage and current at the operation condition. In pulsed operation the element dissipation is basically the product of voltage, current, and duty factor, though pulse shape and circuit conditions may effect actual dissipation values.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts	48.0	53.0	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	30.0	45.0	pF
Cout	---	1.0	pF
Cgp	20.0	28.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	30.0	45.0	pF
Cout	20.0	28.0	pF
Cpk	---	1.0	pF
Zero Bias Plate Current (E_b = 5000 volts)	0.36	0.52	A
Cut-off Bias (E_b = 5000 volts, I_b = 1.0 mAdc)	---	-45.0	V

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CX3000H7 must be mounted vertically, base down or up at the convenience of the circuit designer.

COOLING - The maximum temperature rating for the anode core and the ceramic/metal seal areas of the tube is 250°C, and sufficient forced-air cooling must be provided to assure operation at safe tube temperatures. Tube life is usually prolonged if cooling in excess of absolute minimum requirements is provided for cooler tube temperatures.

The filament leads of the 3CX3000H7 are attached to the tube with soft solder, and care must therefore be taken to supply sufficient cooling to this area of the tube to maintain temperatures below 150°C to avoid melting or loosening of these leads.

Minimum air flow requirements to maintain anode core and ceramic/metal seal areas below 225°C at sea level with an inlet-air temperature of 50°C are tabulated for air-flow in the base-to-anode and anode-to-base directions. At higher ambient temperatures, frequencies above 30 MHz, or at higher altitudes, a greater quantity of air will be required.

With air flowing in a base-to-anode direction, and with the specified air also flowing past the base section of the tube, no additional base cooling of the tube is normally required. With air flowing in an anode-to-base direction, the tube requires additional cooling air directed into the filament stem structure, between the inner and outer filament terminals, in the amount of 5 cfm minimum, directed by an appropriate air nozzle or pipe.

It is suggested that temperatures, especially in the base area of the tube, be monitored in any new installation to insure proper cooling. Temperatures may be measured with any of the available temperature-sensing paint or crayon materials.

Anode-to-Base Air Flow				
	Sea Level		10,000 Feet	
Anode Dissipation watts	Air Flow CFM	Pressure Drop Inches water	Air Flow CFM	Pressure Drop Inches water
2000	49	0.31	71	0.45
3000	85	0.72	124	1.40
4000	127	1.40	185	2.55
Base-to-Anode Air Flow				
2000	46	0.3	67	0.44
3000	72	0.6	105	0.88
4000	99	1.0	145	1.46

ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line fluctuations of from 7.12 to 7.87 volts.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the filament. The circuit should be so arranged that rf drive cannot be applied in the absence of normal plate voltage.

INPUT CIRCUIT - When operated as a grounded-grid rf amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single-ended amplifier, and depending on the application, it is suggested the cathode tank circuit operate with a Q of five or more.

HIGH FREQUENCY OPERATION - The 3CX3000H7 is usable to 110 MHz, with a plate voltage reduction to 4000 volts for rf service, if the rf connections to the filament contacts are properly made directly at the base of the tube.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as these, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal cooling airflow interlock and plate over-current interlock it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

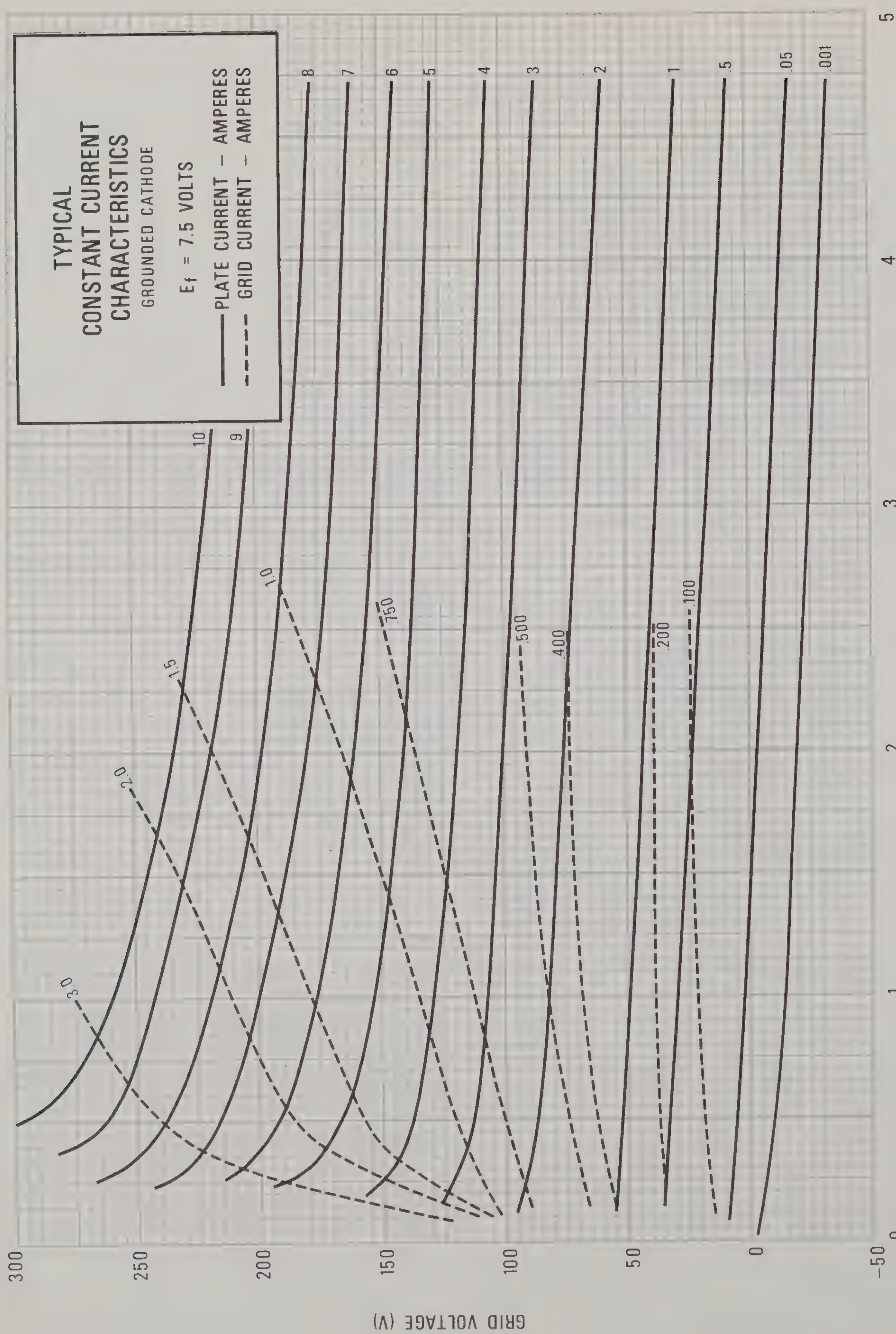
In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

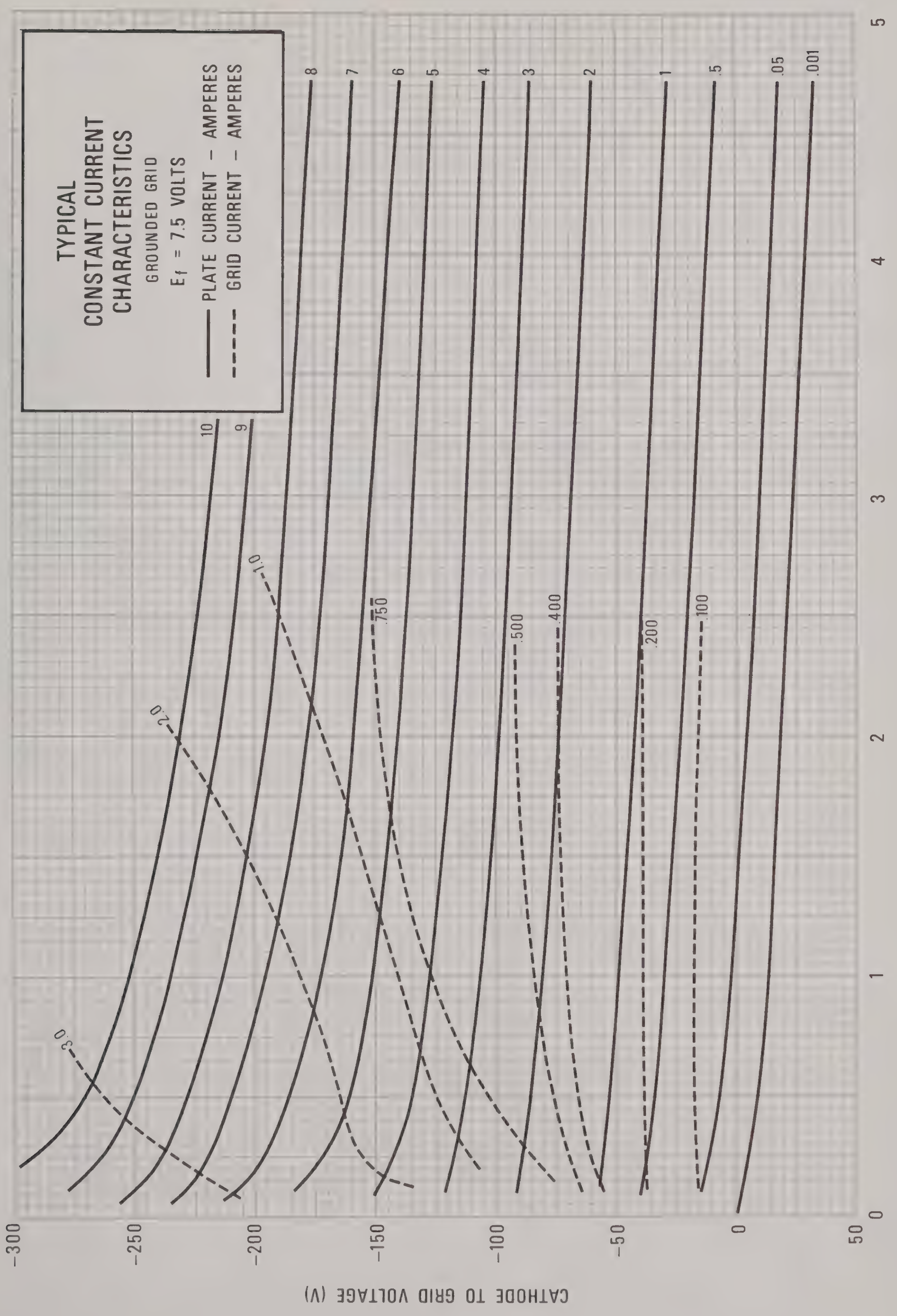
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



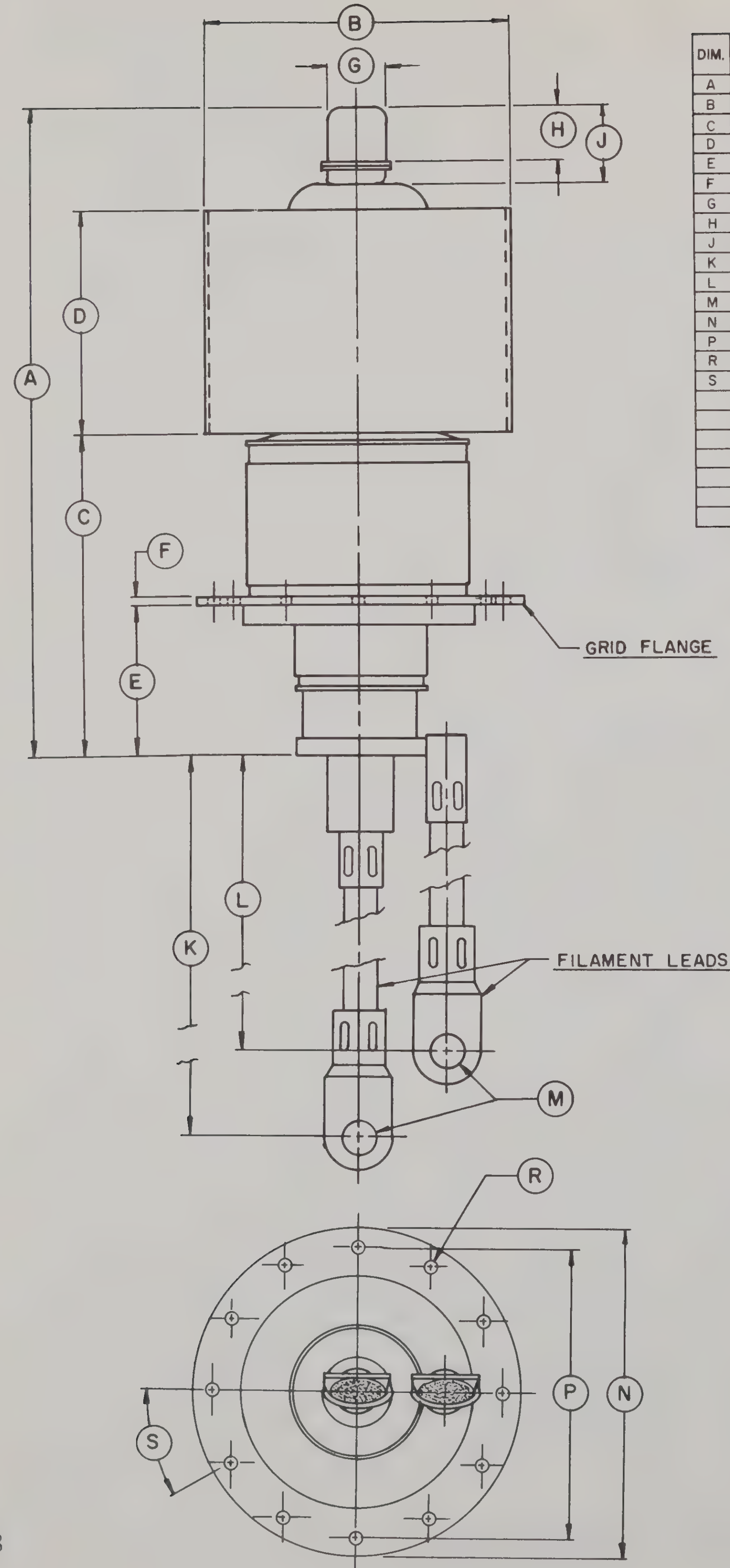
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.5
1.0
.750
.500
.400
.200
.100
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
0
1
2
3
4
5
300
250
200
150
100
50
0
–50

CURVE #3373



TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.0
.750
.500
.400
.200
.100
CATHODE TO GRID VOLTAGE (V)
–300
–250
–200
–150
–100
–50
0
50
PLATE TO GRID VOLTAGE (KV)
0
1
2
3
4
5

CURVE #3375



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.000	9.000	- -	203.20	228.60	- -
B	4.093	4.156	- -	103.96	105.56	- -
C	3.875	4.250	- -	98.43	107.95	- -
D	2.937	3.062	- -	74.60	77.77	- -
E	1.703	1.953	- -	43.26	49.61	- -
F	- -	- -	0.125	- -	- -	3.18
G	0.781	0.843	- -	19.84	21.41	- -
H	0.687	0.812	- -	17.45	20.62	- -
J	1.000	1.125	- -	25.40	28.58	- -
K	8.937	9.437	- -	227.00	239.70	- -
L	7.937	8.437	- -	201.60	214.30	- -
M	- -	- -	0.390	- -	- -	9.91
N	4.230	4.250	- -	107.44	107.95	- -
P	3.855	3.885	- -	97.92	98.68	- -
R	- -	- -	0.250	- -	- -	6.35
S	29°	31°	- -	29°	31°	- -

NOTES:

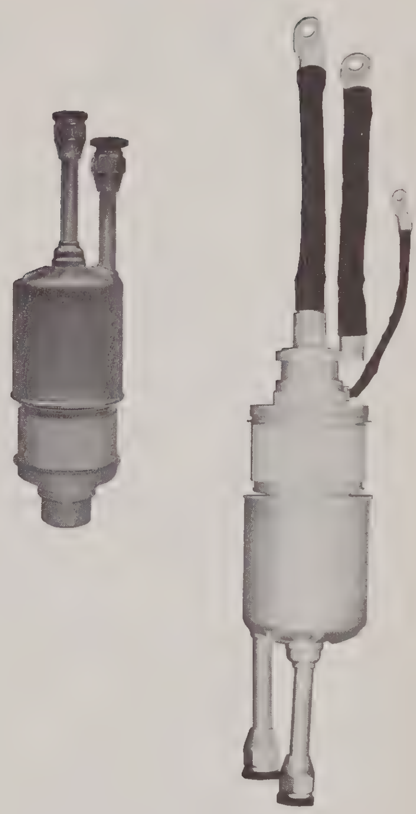
1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. THERE ARE 12 HOLES IN GRID FLANGE.
3. GRID FLANGE AND FILAMENT LEADS ARE TO BE ORIENTED AS SHOWN

EIMAC®

TECHNICAL DATA

3CW5000A7
3CW5000F7

HIGH-MU WATER-COOLED POWER TRIODES



The EIMAC 3CW5000A7 and 3CW5000F7 are ceramic/metal, water-cooled, high-mu triodes for use as an amplifier, oscillator, or modulator, or in voltage regulator applications. Their maximum rated anode dissipation is 5000 watts.

These tubes are water-cooled versions of the air-cooled 3CX3000A7 and 3CX3000F7.

The 3CW5000A7 sockets coaxially and has a low-inductance cylindrical filament-stem structure which readily becomes part of a linear filament tank circuit for VHF operation. The 3CW5000F7 tube is identical except for the addition of flexible leads on the base for grid and filament connections, which can simplify socketing in low-frequency operations.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded-grid operation is attractive since a power gain of over 20 times can be obtained.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten	
Voltage	7.5 V
Current @ 7.5 V (3CW5000A7)	51.5 A
(3CW5000F7)	50.5 A
Amplification Factor (Average)	160
Direct Interelectrode Capacitances (grounded filament)[2]	
Cin	38.0 pF
Cout	0.6 pF
Cgp	24.0 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	38.0 pF
Cout	24.0 pF
Cpk	0.6 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

Frequency of Maximum Rating: (3CW5000A7)	110 MHz
(3CW5000F7)	30 MHz

MECHANICAL

Maximum Overall Dimensions:	
Length (3CW5000A7)	12.625 in; 32.07 cm
(3CW5000F7, incl. fil. leads)	22.062 in; 56.04 cm
Diameter (both types)	3.625 in; 9.22 cm
Operating Position	Vertical, base up or down
Net Weight: (3CW5000A7) Approximate	4.8 lb; 2.2 kg
(3CW5000F7) Approximate	5.5 lb; 2.5 kg
Cooling	Water and Forced Air
Base (3CW5000A7)	Special Coaxial
(3CW5000F7)	Special with Flying Leads
Maximum Operating Temperature:	
Envelope and Ceramic/Metal Seals	250°C
Filament Lead/Tube Base Junctions (3CW5000F7)	150°C

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN
Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Bias voltage may be required.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4800	4800	4900	Vdc
Zero-Signal Plate Current[1]	0.35	0.35	0.36	Adc
Single-Tone Plate Current	1.68	2.00	2.25	Adc
Single-Tone Grid Current[2]	0.46	0.60	0.65	Adc
Driving Power[2]	293	410	535	W
Plate Dissipation	2275	2775	2775	W
Single-Tone Plate Output Power	6000	7266	8250	W
Resonant Load Impedance	1720	1425	1308	Ω
Driving Impedance	50.0	46.3	49.2	Ω

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Bias Voltage may be required.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Grid Driven, Carrier Conditions

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1]	0.25	0.36	Adc
DC Plate Current	0.74	1.23	Adc
DC Grid Current[1]	0.13	0.17	Adc
Peak rf Grid Voltage[2]	85.0	125	v
Driving Power[2]	11.5	21.2	W
Plate Dissipation	1830	3840	W
Carrier Plate Output Power	1130	2200	W
Resonant Load Impedance	1750	1100	Ω
Peak rf Plate Voltage	2000	2200	v

RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM, Cathode Driven
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz for 3CW5000A7, to 30 MHz for 3CW5000F7)

Plate Voltage	4900	Vdc
Grid Voltage	-50	Vdc
Plate Current	2.16	Adc
Grid Current[1]	0.61	Adc
Peak rf Cathode Voltage[1]	300	v
Calculated Driving Power[1]	691	W
Plate Dissipation	2315	W
Useful Output Power[2]	7500	W

1. Approximate value.
2. Output circuit and filter loss of 10% assumed.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_2, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.
2. Per tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1,3]	0.50	0.72	Adc
Max. Signal Plate Current	3.58	4.72	Adc
Max. Signal Grid Current[1]	0.58	1.10	Adc
Peak af Grid Voltage[2]	190	250	v
Driving Power[1]	115	276	W
Max. Signal Plate Dissipation	3820	6618	W
Plate Output Power	10.5	16.4	kW
Load Resistance (plate to plate)	2720	2352	Ω

3. Bias voltage may be required.

VOLTAGE REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	Vdc
DC PLATE CURRENT	4.0	Adc
PULSED PLATE CURRENT	10.0	a
PLATE DISSIPATION (See note)	5,000	W
GRID DISSIPATION (See note)	225	W

NOTE: The equipment designer or user must assure that rated dissipation values are not exceeded. In continuous operation (Class A) element dissipation is simply the product of voltage and current at the operating conditions. In pulsed operation the element dissipation is basically the product of voltage, current, and duty factor, though pulse shape and circuit conditions may effect actual dissipation values.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts (3CW5000A7)	49.0	54.0	A
(3CW5000F7)	48.0	53.0	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	30.0	45.0	pF
Cout	---	1.0	pF
Cgp	20.0	28.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	30.0	45.0	pF
Cout	20.0	28.0	pF
Cpk	---	1.0	pF
Zero Bias Plate Current (E_b = 5000 volts)	0.36	0.52	A
Cut-off Bias (E_b = 5000 volts, I_b = 1.0 mAdc)	---	-45.0	V

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CW5000A7 and 3CW5000F7 must be mounted vertically, base down or up at the convenience of the circuit designer. The filament connections to the 3CW5000A7 should be made through spring collets. These are available from EIMAC with the following part numbers:

149575 Inner line collet
149576 Outer line collet

Reasonable care should be taken that these collets do not impart undue strain to the terminals or the base of the tube.

COOLING - With an anode dissipation of 5000 watts and with an incoming water temperature of 50°C maximum, 7.7 gpm of cooling water must be supplied to the anode cooling jacket. Outlet water temperature from the cooling jacker should never exceed 70°C, and water pressure on the jacket should not exceed 60 psi. The pressure drop across the anode cooling jacket itself, with a water flow of 7.7 gpm, will be approximately 6 psi. The grid-terminal contact surface and adjacent ceramic must be cooled by forced air, with quantity, velocity, and direction adjusted to limit the maximum seal temperature to less than 250°C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cfm should be directed into the space between the inner and outer filament contacting surfaces.

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 KΩ/cm3, and preferably above 250 KΩ/cm3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Both air and water flow must be supplied before or simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with them. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line flucuations of from 7.12 to 7.87 volts.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the heater. The circuit should be so arranged that rf drive cannot be applied in the absence of normal plate voltage.

INPUT CIRCUIT - When operated as a grounded-grid rf amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single-ended amplifier, and depending on the application, it is suggested the cathode tuned circuit operate with a "Q" of 5 or more.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

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FAULT PROTECTION - In addition to normal cooling airflow interlock and plate over-current interlock it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

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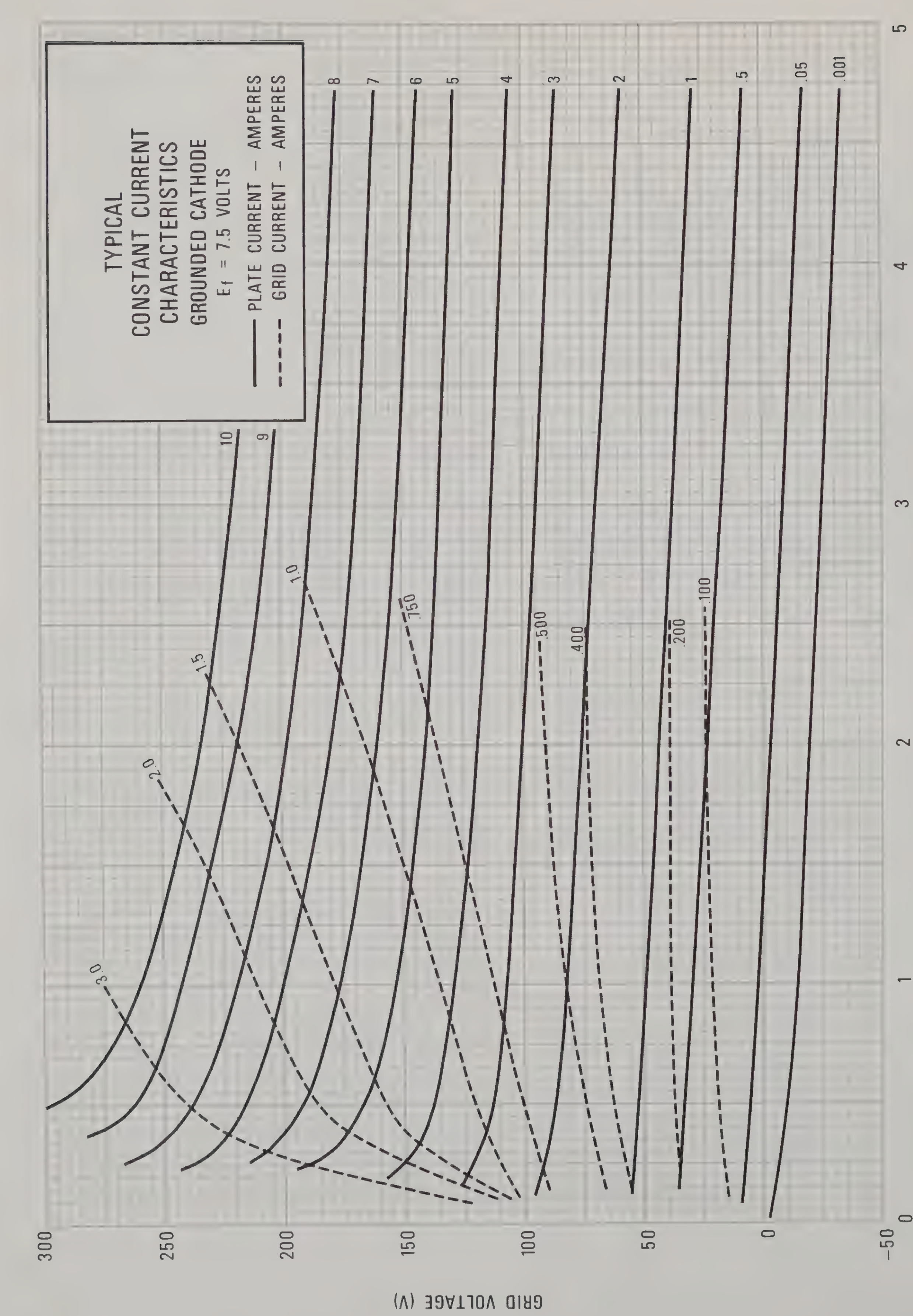
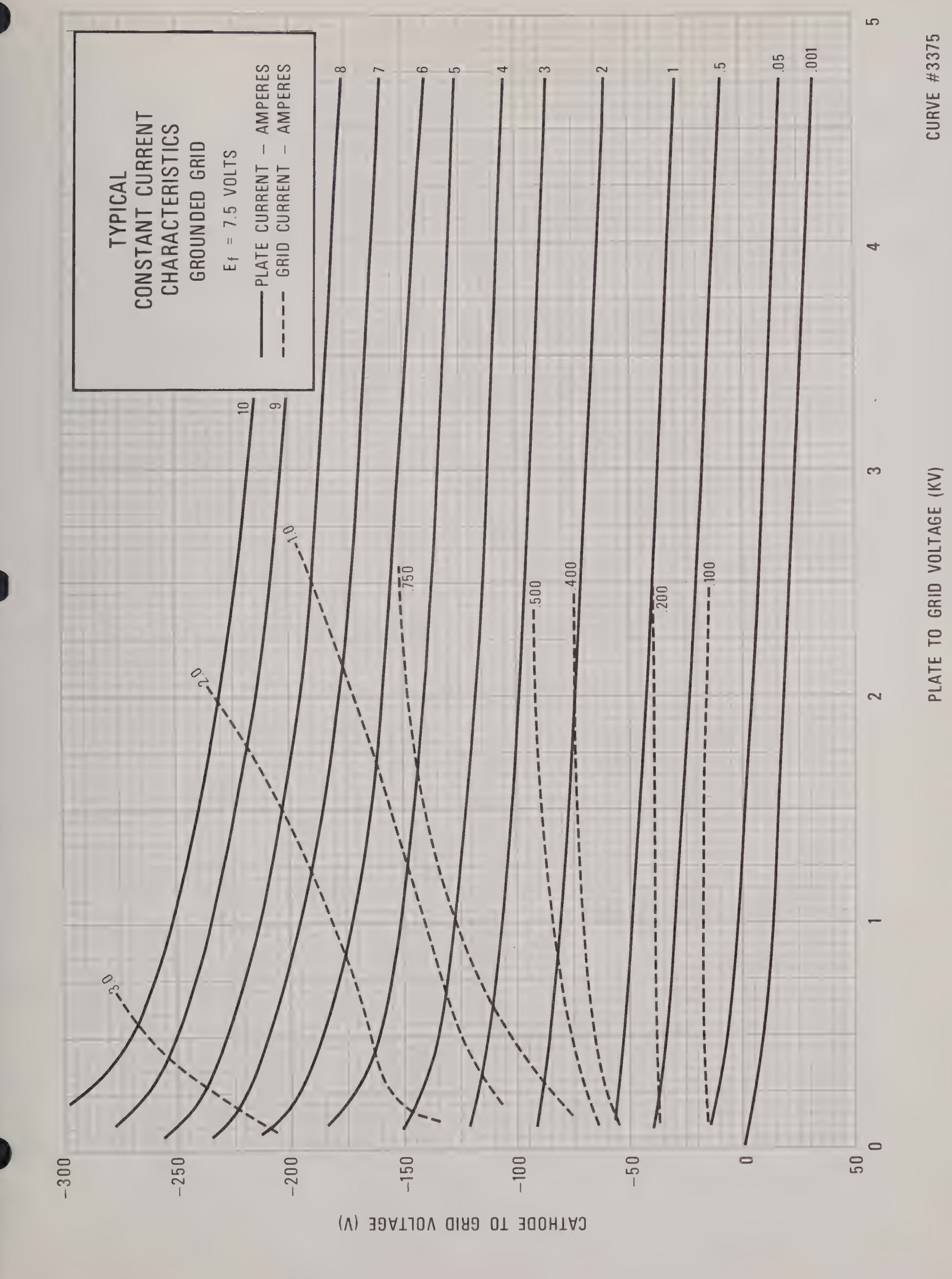
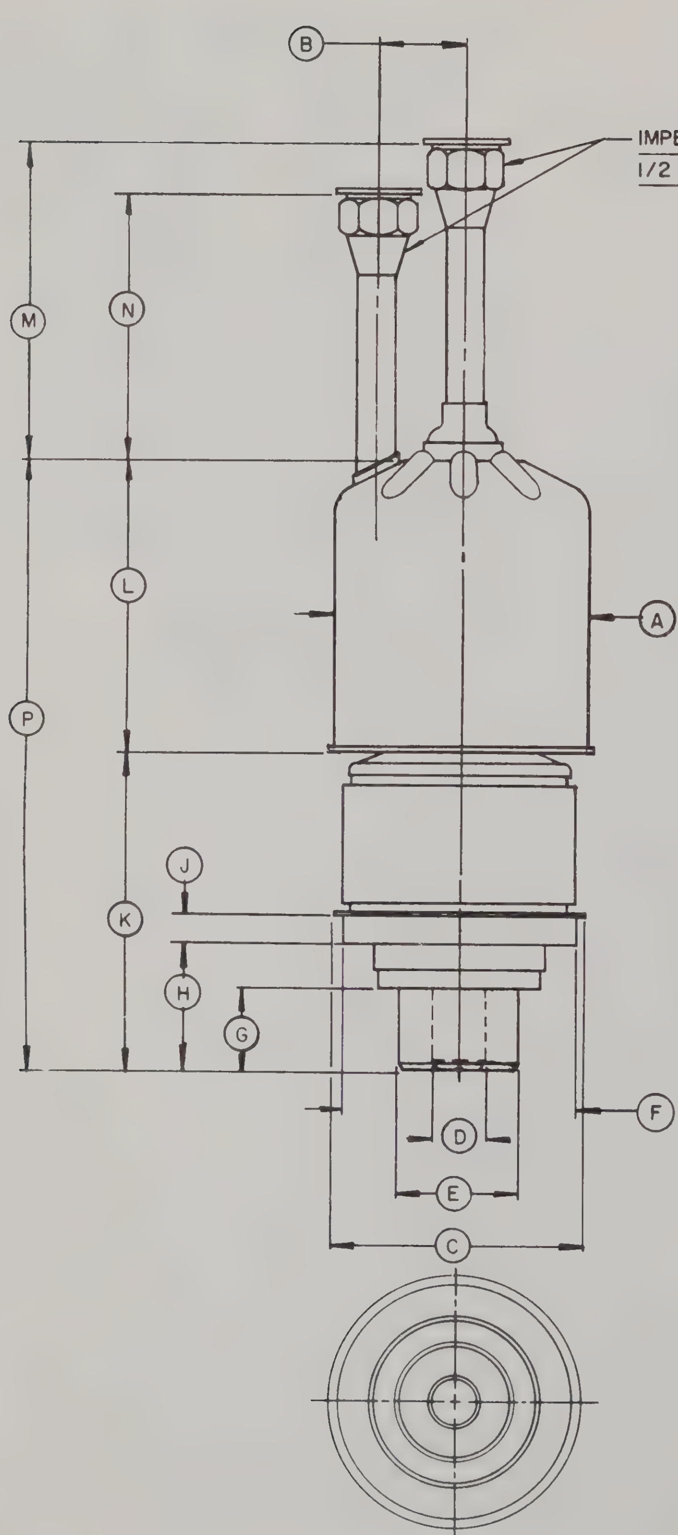

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)

CURVE #3373


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.0
.750
.500
.400
.200
.100
-300
-250
-200
-150
-100
-50
0
50
CATHODE TO GRID VOLTAGE (V)
0
1
2
3
4
5
PLATE TO GRID VOLTAGE (KV)
CURVE #3375

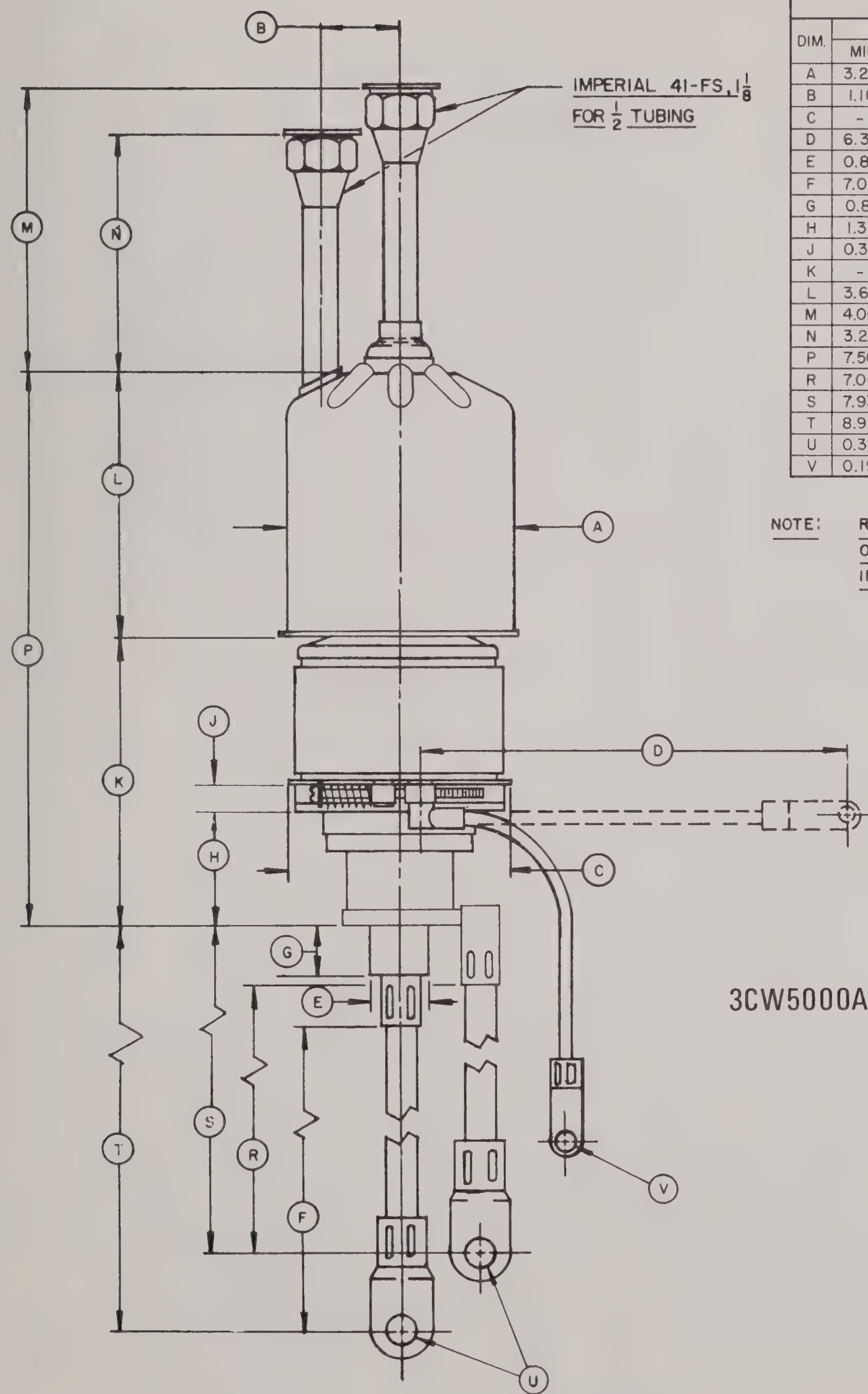


DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	--	82.42	82.68	--
B	1.109	1.141	--	28.17	28.98	--
C	--	3.625	--	--	92.08	--
D	0.615	0.635	--	15.62	16.13	--
E	1.490	1.510	--	37.85	38.35	--
F	2.990	3.010	--	75.95	76.45	--
G	0.812	0.938	--	20.62	23.83	--
H	1.375	1.625	--	34.93	41.28	--
J	0.359	0.422	--	9.12	10.72	--
K	--	--	3.599	--	--	91.41
L	3.625	3.875	--	92.08	98.43	--
M	4.000	4.500	--	101.60	114.30	--
N	3.250	3.750	--	82.55	95.25	--
P	7.500	8.125	--	190.50	206.38	--

DIMENSIONAL DATA

NOTE: REF DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.

3CW5000F7



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	- -	82.42	82.68	- -
B	1.109	1.141	- -	28.17	28.98	- -
C	- -	3.625	- -	- -	92.08	- -
D	6.375	6.625	- -	161.93	168.28	- -
E	0.859	0.890	- -	21.82	22.61	- -
F	7.000	7.500	- -	177.80	190.50	- -
G	0.812	0.938	- -	20.62	23.83	- -
H	1.375	1.625	- -	34.93	41.28	- -
J	0.359	0.422	- -	9.12	10.72	- -
K	- -	- -	3.599	- -	- -	91.41
L	3.625	3.875	- -	92.08	98.43	- -
M	4.000	4.500	- -	101.60	114.30	- -
N	3.250	3.750	- -	82.55	95.25	- -
P	7.500	8.125	- -	190.50	206.38	- -
R	7.000	7.500	- -	177.80	190.50	- -
S	7.937	8.437	- -	201.60	214.30	- -
T	8.937	9.437	- -	226.99	239.70	- -
U	0.385	0.395	- -	9.78	10.03	- -
V	0.194	0.200	- -	4.93	5.08	- -

NOTE: REF. DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.

3CW5000A7

TECHNICAL DATA

3CW5000H7

HIGH-MU
WATER-COOLED
POWER TRIODES

The EIMAC 3CW5000H7 is a ceramic/metal, water-cooled, high-mu triode for use as an amplifier, oscillator, or modulator, or in voltage regulator applications. The maximum rated anode dissipation is 5000 watts.

The anode water jacket includes a mounting flange, and no socket is required since the grid terminates in another flange and the filament connection is made through flexible leads on the base.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded-grid operation is attractive since a power gain of over 20 times can be obtained.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten	
Voltage	7.5 V
Current @ 7.5 V	50.5 A
Amplification Factor (Average)	160
Direct Interelectrode Capacitances (grounded filament)[2]	
Cin	38.0 pF
Cout	0.6 pF
Cgp	24.0 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	38.0 pF
Cout	24.0 pF
Cpk	0.6 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

Printed in U.S.A.

Frequency of Maximum Rating: (See application note on High Frequency Operation) . 30 MHz

MECHANICAL

Overall Dimensions:

Length (Include filament leads)	18.62 in; 47.29 cm
Diameter (Anode Mounting Flange)	5.42 in; 13.77 cm
Operating Position	Vertical, base up or down
Net Weight: Approximate	7.5 lb; 3.4 kg
Cooling	Water and Forced Air
Base	Special with Flying Leads

Maximum Operating Temperature:

Envelope and Ceramic/Metal Seals	250°C
Filament Lead/Tube Base Junctions	150°C

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Bias voltage may be required.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4800	4800	4900	Vdc
Zero-Signal Plate Current[1]	0.35	0.35	0.36	Adc
Single-Tone Plate Current	1.68	2.00	2.25	Adc
Single-Tone Grid Current[2]	0.46	0.60	0.65	Adc
Driving Power[2]	293	410	535	W
Plate Dissipation	2275	2775	2775	W
Single-Tone Plate Output Power	6000	7266	8250	W
Resonant Load Impedance	1720	1425	1308	Ω
Driving Impedance	50.0	46.3	49.2	Ω

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Bias Voltage may be required.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Grid Driven, Carrier Conditions

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1]	0.25	0.36	Adc
DC Plate Current	0.74	1.23	Adc
DC Grid Current[1]	0.13	0.17	Adc
Peak rf Grid Voltage[2]	85.0	125	v
Driving Power[2]	11.5	21.2	W
Plate Dissipation	1830	3840	W
Carrier Plate Output Power	1130	2200	W
Resonant Load Impedance	1750	1100	Ω
Peak rf Plate Voltage	2000	2200	v

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM, Cathode Driven
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	4900	Vdc
Grid Voltage	-50	Vdc
Plate Current	2.16	Adc
Grid Current[1]	0.61	Adc
Peak rf Cathode Voltage[1]	300	v
Calculated Driving Power[1]	691	W
Plate Dissipation	2315	W
Useful Output Power[2]	7500	W

1. Approximate value.
2. Output circuit and filter loss of 10% assumed.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_2, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.
2. Per tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1,3]	0.50	0.72	Adc
Max. Signal Plate Current	3.58	4.72	Adc
Max. Signal Grid Current[1]	0.58	1.10	Adc
Peak af Grid Voltage[2]	190	250	v
Driving Power[1]	115	276	W
Max. Signal Plate Dissipation	3820	6618	W
Plate Output Power	10.5	16.4	kW
Load Resistance (plate to plate)	2720	2352	Ω

3. Bias voltage may be required.

VOLTAGE REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	Vdc
DC PLATE CURRENT	4.0	Adc
PULSED PLATE CURRENT	10.0	a
PLATE DISSIPATION (See note)	5,000	W
GRID DISSIPATION (See note)	225	W

NOTE: The equipment designer or user must assure that rated dissipation values are not exceeded. In continuous operation (Class A) element dissipation is simply the product of voltage and current at the operating conditions. In pulsed operation the element dissipation is basically the product of voltage, current, and duty factor, though pulse shape and circuit conditions may effect actual dissipation values.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. This current variation causes no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts	48.0	53.0	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	30.0	45.0	pF
Cout	---	1.0	pF
Cgp	20.0	28.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	30.0	45.0	pF
Cout	20.0	28.0	pF
Cpk	---	1.0	pF
Zero Bias Plate Current (E_b = 5000 volts)	0.36	0.52	A
Cut-off Bias (E_b = 5000 volts, I_b = 1.0 mAdc)	---	-45.0	V

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CW5000H7 must be mounted vertically, base down or up at the convenience of the circuit designer.

COOLING - With an anode dissipation of 5000 watts and with an incoming water temperature of 50 °C maximum, 7.7 gpm of cooling water must be supplied to the anode cooling jacket. Outlet water temperature from the cooling jacket should never exceed 70 °C, and water pressure on the jacket should not exceed 60 psi. The pressure drop across the anode cooling jacket itself, with a water flow of 7.7 gpm, will be approximately 6 psi. The grid-terminal contact surface and adjacent ceramic must be cooled by forced air, with quantity, velocity, and direction adjusted to limit the maximum seal temperature to less than 250 °C.

The filament leads of the 3CW5000H7 are attached to the tube with soft solder and care must therefore be taken to supply sufficient forced-air cooling to this area of the tube to maintain temperatures below 150 °C to avoid melting or loosening of these leads.

Additional air should be directed around the envelope and grid-flange area to assure adequate cooling of these seal areas and the envelope.

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 $K\Omega/cm^3$, and preferably above 250 $K\Omega/cm^3$. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Both air and water flow must be supplied befor or simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with them. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line fluctuations of from 7.12 to 7.87 volts.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the heater. The circuit should be so arranged that rf drive cannot be applied in the absence of normal plate voltage.

INPUT CIRCUIT - When operated as a grounded-grid rf amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single-ended amplifier, and depending on the application, it is suggested the cathode tuned circuit operate with a "Q" of 5 or more.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attentuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as this, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

HIGH FREQUENCY OPERATION - The 3CW5000H7 is usuable to 110 MHz, with a plate voltage reduction to 4000 volts, if the rf connections to the filament contacts are properly made directly at the base of the tube.

FAULT PROTECTION - In addition to normal cooling airflow interlock and plate over-current interlock it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

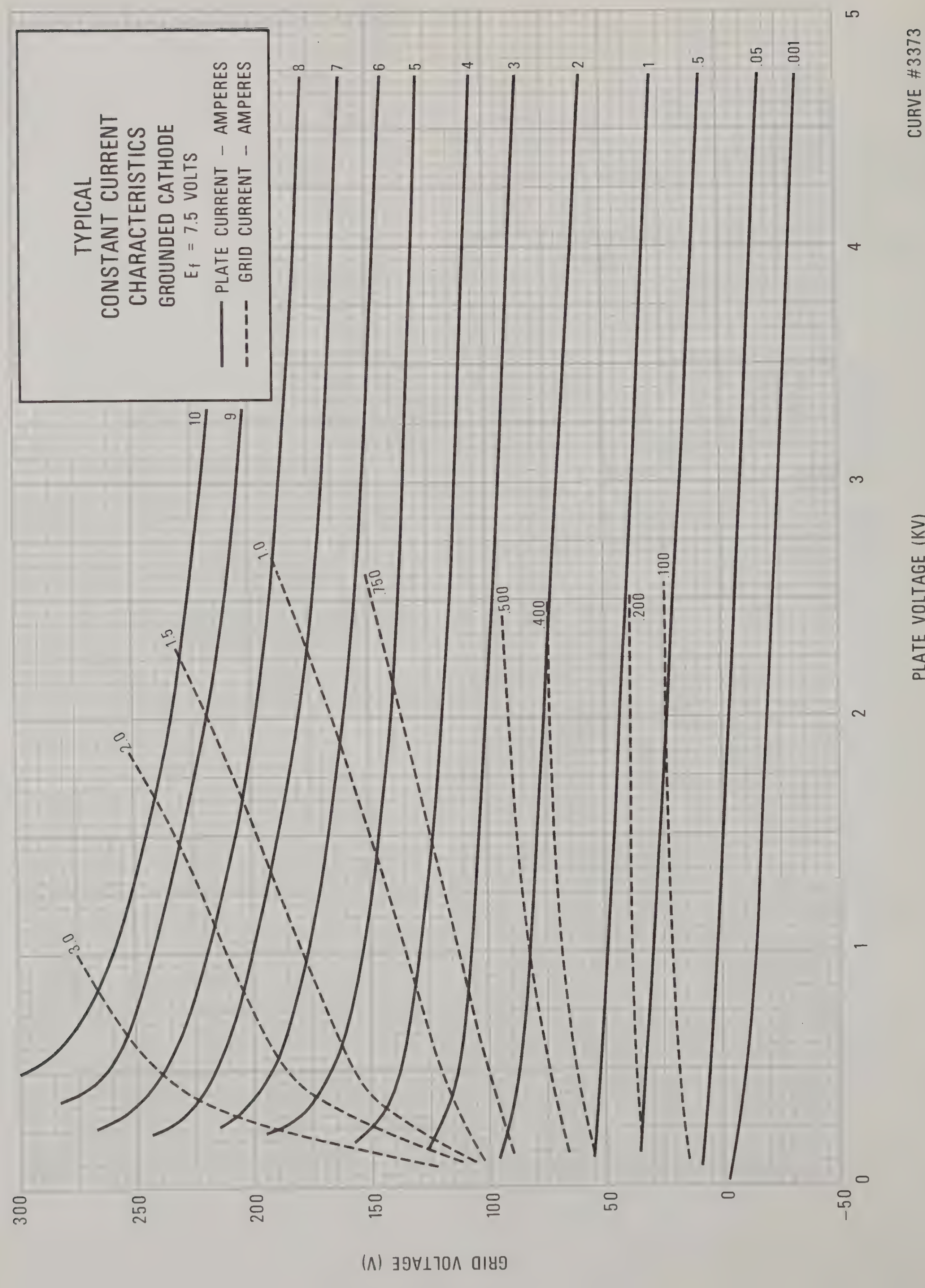
HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

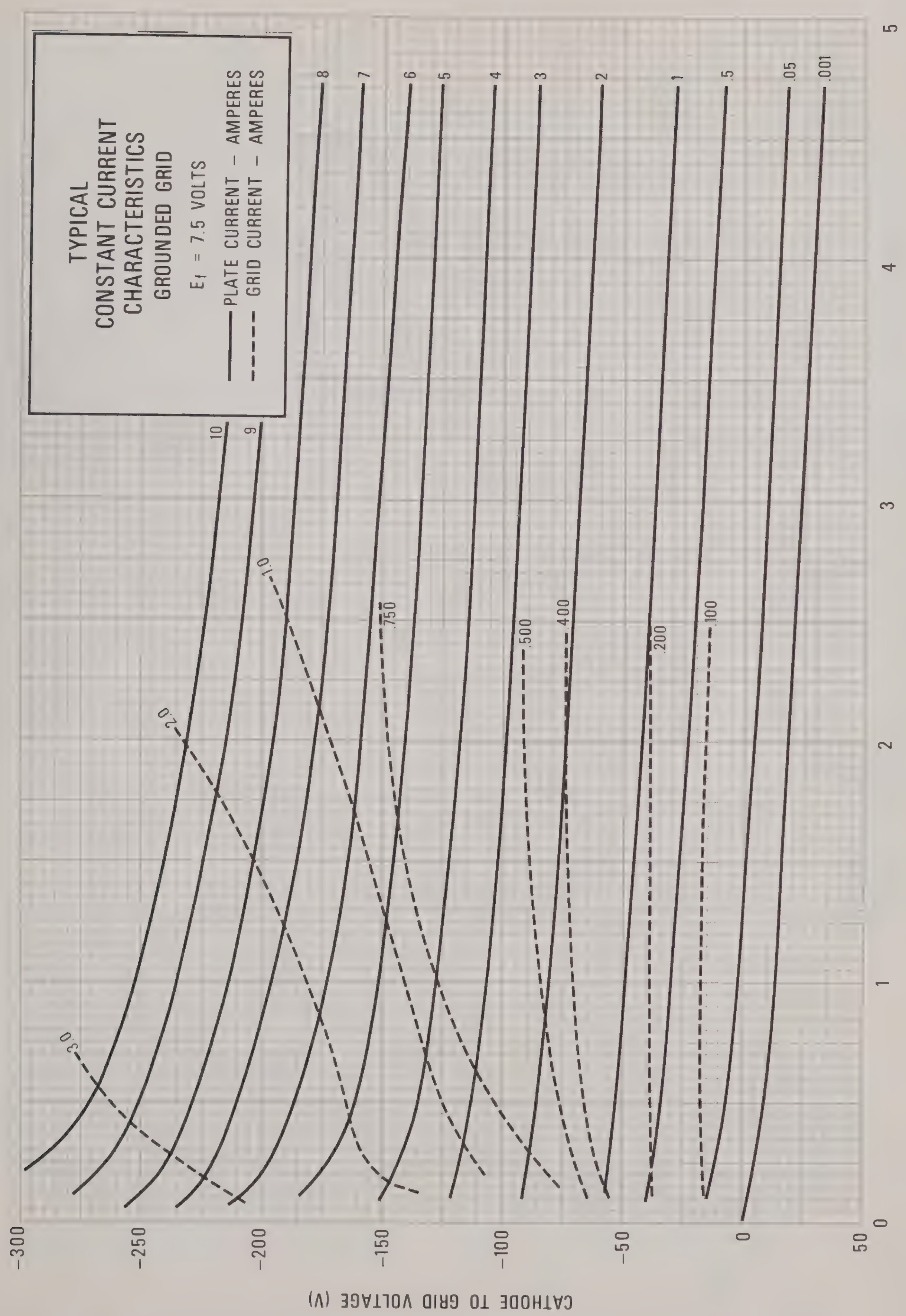
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers.

The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

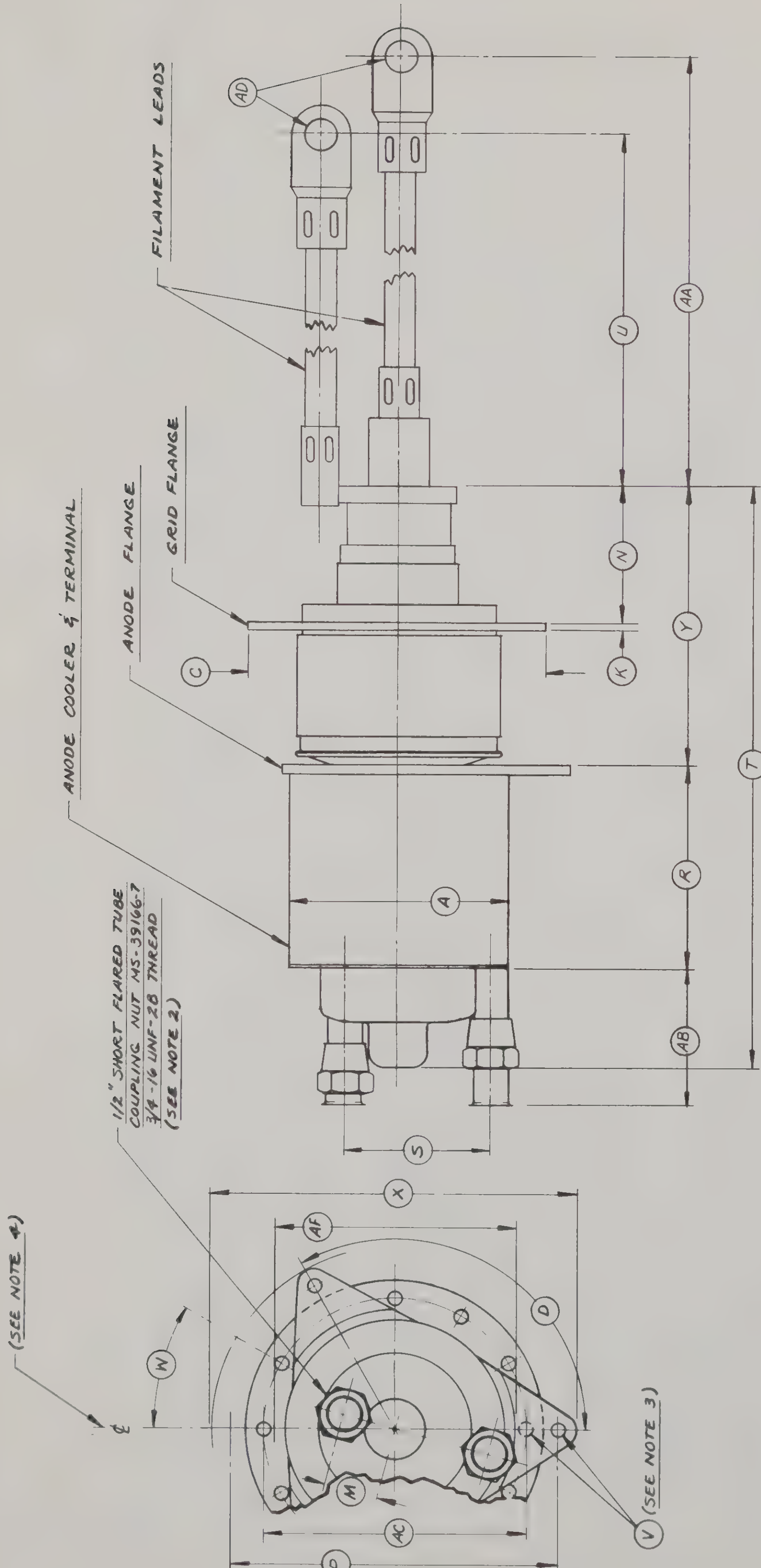
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE #3373


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PLATE TO GRID VOLTAGE (KV)
CATHODE TO GRID VOLTAGE (V)
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.0
.750
.500
.400
.200
.100
-300
-250
-200
-150
-100
-50
0
50
0
1
2
3
4
5

CURVE #3375



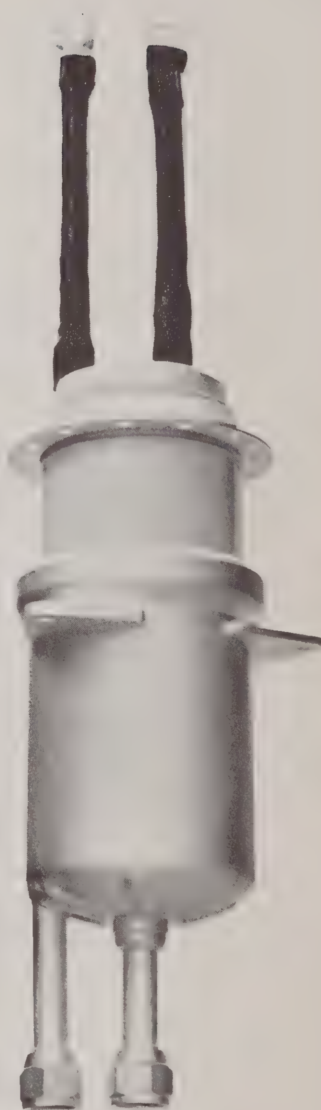
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.235	3.265		82.17	82.93	
C	4.230	4.250		107.44	107.95	
D	118°	122°		118°	122°	
K			.125			3.17
M			.800			20.32
N	1.703	1.953		43.26	49.61	
P	4.615	4.635		117.22	117.73	
R	2.625	2.875		66.67	73.02	
T	7.750	8.750		196.85	222.25	
U	7.937	8.437		201.60	214.30	
V			.250			6.35
W	29°	31°		29°	31°	
X	5.330	5.420		135.38	137.67	
Y	3.875	4.250		98.42	107.95	
AA	8.937	9.437		227.00	239.70	
AB			2.000			50.40
AC	3.855	3.885		97.92	98.68	
AD			.390			9.91
AF			3.625			92.07
S			2.155			54.74

NOTES:
1. REF. DIM. ARE FOR INFO ONLY & ARE NOT REQ'D FOR INSP. PURPOSES.
2. EITHER FITTING CAN BE USED AS INLET OR OUTLET.
3. 3 HOLES IN ANODE FLANGE, 12 HOLES IN GRID FLANGE.
4. MTG. FLANGE, FIL. LEADS & WATER FITTINGS ARE TO BE ORIENTED AS SHOWN.

TECHNICAL DATA

3CW40,000H3

MEDIUM–MU
WATER–COOLED
POWER TRIODE



The EIMAC 3CW40,000H3 is a water-cooled, ceramic/metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated at 40 kilowatts of plate dissipation with low waterflow and pressure drop.

Input of 100 kilowatts is permissible up to 90 megahertz. Plentiful reserve emission is available from its 1500 watt filament. The grid structure is rated at 750 watts, making this tube an excellent choice for severe applications.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten
- Voltage . . . . 10.0 ± 0.5 V
- Current, at 10.0 volts . . . . 160 A

Direct Interectrode Capacitance (grounded cathode)[2]
- Cin . . . . 70.0 pF
- Cout . . . . 2.3 pF
- Cgp . . . . 43.0 pF

Frequency of Maximum Rating:
- CW . . . . 90 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Overall Dimensions:
- Length (including base leads) . . . . 21.22 In; 53.9 cm
- Diameter (anode mounting flange) . . . . 6.75 In; 17.1 cm

Net weight . . . . 14 lb; 6.4 kg

Operating Position . . . . Vertical

Maximum Operating Temperature:
- Ceramic/Metal Seals & Envelope . . . . 250°C

Base . . . . Special, with grid contact flange & filament flying leads
Cooling . . . . Water or equivalent liquid & forced air

RADIO FREQUENCY INDUSTRIAL OSCILLATOR

Class C (Filtered dc power supply)

ABSOLUTE MAXIMUM RATINGS:

PLATE VOLTAGE	12.0	KILOVOLTS
PLATE CURRENT	9.0	AMPERES
GRID VOLTAGE	-1.2	KILOVOLTS
GRID CURRENT	1.2	AMPERES
PLATE INPUT POWER	100	KILOWATTS
PLATE DISSIPATION	40	KILOWATTS

TYPICAL OPERATION [1]

Plate Voltage	7.0	10.0	kVdc
Plate Current	7.7	9.0	Adc
Grid Voltage	-700	-850	Vdc
Grid Current [2]	0.53	0.74	Adc
Peak Pos. Grid Voltage [2]	440	550	v
Driving Power [2]	600	1040	W
Plate Input Power	54	90	kW
Plate Dissipation [2]	16	20	kW
Plate Output Power [2]	37.7	70	kW
Approx. Load Impedance	408	526	Ω

1 Loaded conditions.
2 Approximate value.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. This current variation causes no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 10.0 volts	152	168	A
Interelectrode Capacitances [1] (grounded cathode connection)			
Cin	65.0	75.0	pF
Cout	2.0	2.6	pF
Cgp	38.0	48.0	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

ELECTRICAL

FILAMENT -- The rated filament voltage for the 3CW40,000H3 is 10.0 volts. Filament voltage, as measured at the tube, should be maintained at this value for consistent performance and good tube life. In no case should it be allowed to vary from 10.0 volts by more than plus or minus five percent.

CONTROL GRID OPERATION -- The grid current rating is 1.2 ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.3 or 0.6 amp grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 750 watts.

PLATE OPERATION -- Maximum plate voltage rating of 12,000 volts and maximum plate current of 9.0 amps should not be applied simultaneously as rated plate dissipation may be exceeded. The 100 kilowatts input rating applies for Class-C amplifier or oscillator service with no modulation.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an over-load or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

HIGH FREQUENCY OPERATION -- The 3CW40,000H3 is usable to 120 HMz. At this frequency, plate voltage must be reduced to 7000 volts in Class-C service.

MECHANICAL

MOUNTING -- The 3CW40,000H3 must be mounted vertically, either base up or down.

COOLING -- The anode of the 3CW40,000H3 is cooled by circulating water through the integral anode-water jacket. The table below lists minimum water-flow rates at various plate dissipation levels. The table is based on a water temperature rise of 15°C.

MINIMUM COOLING WATER-FLOW REQUIREMENTS

Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
20	15	19
30	16	21
40	17	24
50	18	28

Since power dissipated by the filament represents 1500 watts and grid dissipation can reach 750 watts, 2250 watts has been added to anode dissipation in preparing this tabulation.

When the tube is mounted with the anode up, the outer cooler pipe should be used as the water inlet. When the tube is mounted anode down, the center cooler pipe should be used as the water inlet.

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 $K\Omega/cm^3$, and preferably above 250 $K\Omega/cm^3$. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Forced-air cooling of the base is also required, with 50 to 100 cfm of air at 50°C maximum directed up into and around the base of the tube to cool the grid and filament contact areas.

Both anode and base cooling should be applied before or simultaneously with electrode voltages, including the filament, and should normally be maintained for a short period of time after all voltages are removed to allow for tube cooldown.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must no be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

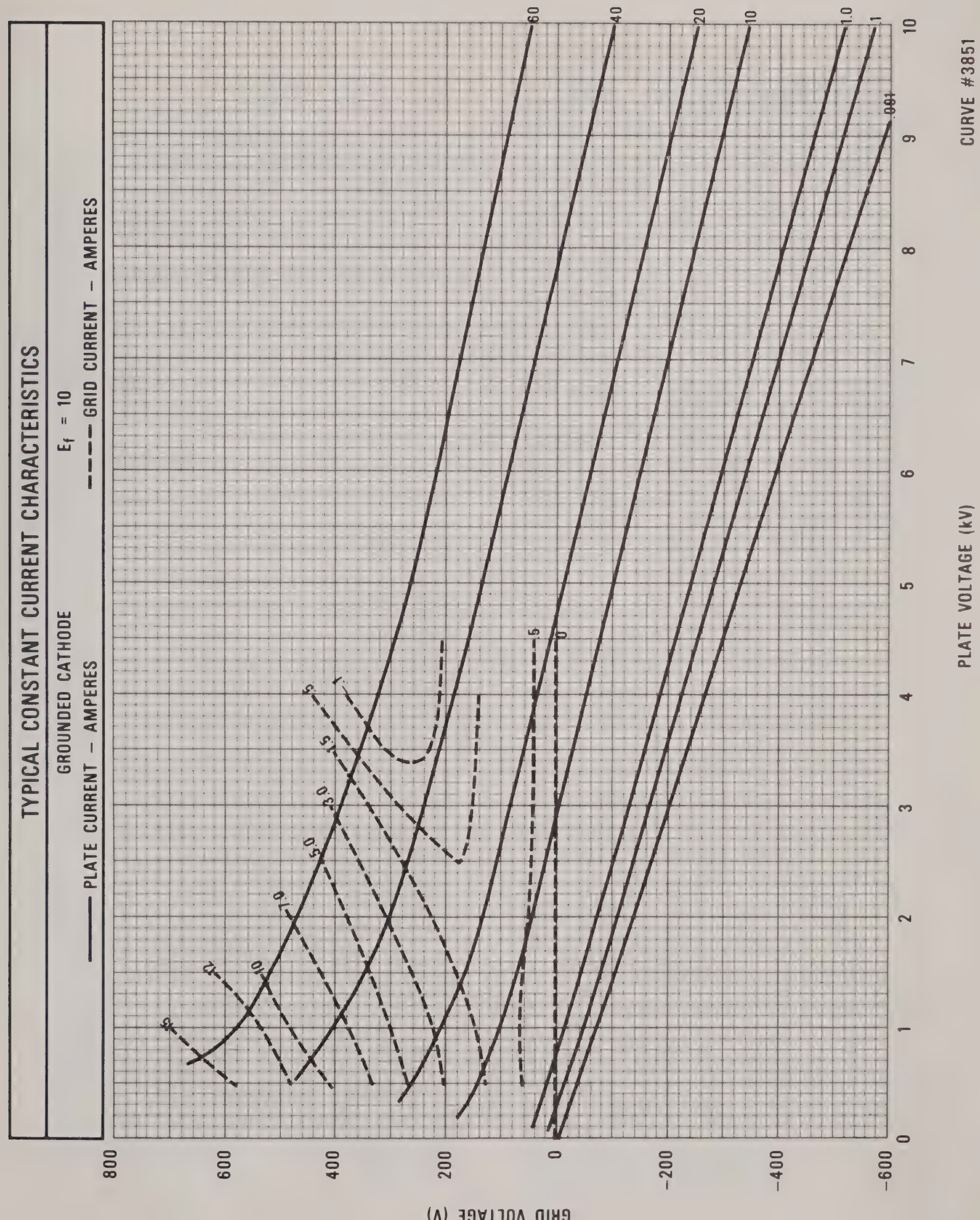
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attentuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

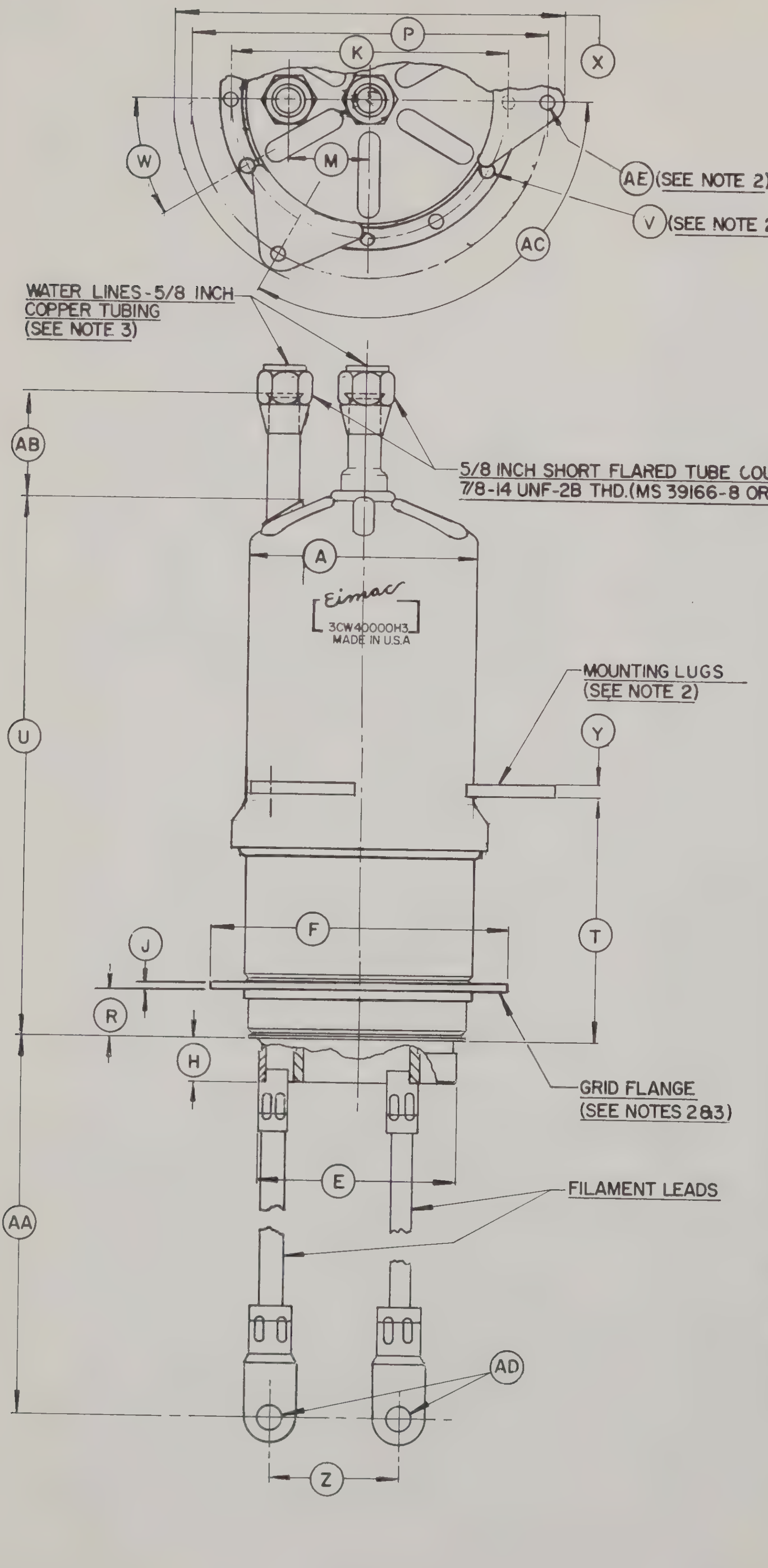
FAULT PROTECTION - In addition to normal plate over-current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 10
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE #3851

3CW40,000H3



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.062	4.188		103.2	106.4	
E	3.230	3.270		82.0	83.1	
F	5.030	5.090		127.8	129.3	
G						
H	.530	.700		13.5	17.8	
J			.125			3.2
K	4.425	4.445		112.4	112.9	
M			1.625			41.3
P	5.957	6.025		151.3	153.0	
R	.700	.860		17.8	21.8	
T	4.350	4.450		110.5	113.0	
U	9.400	9.600		238.8	243.8	
V			.250			6.4
W	29°	31°		29°	31°	
X			6.750			171.5
Y			.250			6.4
Z			2.000			50.8
AA	8.500	9.000		215.9	228.6	
AB			2.625			66.7
AC	118°	122°		118°	122°	
AD			.390			9.9
AE			.265			6.7

NOTES:
1. REF DIMS ARE FOR INFO. ONLY AND ARE NOT REQD FOR INSPECTION PURPOSES.
2. 3 MTG. HOLES IN MTG. LUGS & 12 IN THE GRID FLANGE.
3. GRID FLANGE, WATER FITTINGS, & FIL. LEADS ORIENTED AS SHOWN.

TECHNICAL DATA

8590
4CPX250K

RADIAL BEAM TETRODE

The EIMAC 8590/4CPX250K is a compact forced-air cooled, external anode radial beam tetrode, intended for wideband grid-pulsed radio frequency amplifier and pulse modulator service.

The 8590/4CPX250K has a maximum anode dissipation of 250 watts and is capable of delivering pulse output power in excess of 10 kW with 10 db gain when cathode driven at 450 MHz.

The tube is of coaxial construction and especially designed for cavity operation.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: Voltage	6.0 ± 0.3 V
Current, at 6.0 volts	2.5 A

Amplification Factor (Average):

Grid to Screen	5

Direct Interelectrode Capacitances (Grounded grid)[2]

Input	14.0 pF
Output	4.1 pF
Feedback	.006 pF

Frequency of Maximum Rating:

CW	500 MHz
Plate or Grid-Pulsed	500 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:

Length	2.81 in; 71.37 mm
Diameter	1.64 in; 41.66 mm
Net Weight	4 oz; 114 gm
Operating Position	Any

 Printed in U.S.A.

MECHANICAL

Maximum Operating Temperature:

Ceramic/Metal Seals	250 °C
Anode Core	250 °C
Cooling	Forced-Air
Base	Coaxial

Socketing: EIMAC collets are available as follows:

Heater pin connection	EIMAC Part No. 008290
Cathode connection	EIMAC Part No. 008291
Control grid connection	EIMAC Part No. 008292
Anode connection	EIMAC Part No. 008294
Screen grid connection	EIMAC Part No. 882931

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2500	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.250	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION

Plate Voltage	1000	1500	2000	2500	Vdc
Screen Voltage	250	250	250	250	Vdc
Grid Voltage	-90	-90	-90	-90	Vdc
Plate Current	250	250	250	250	mAdc
Screen Current [1]	38	21	19	16	mAdc
Grid Current [1]	31	28	26	25	mAdc
Peak rf Grid Voltage [1]	114	112	112	111	v
Calculated Driving Power [1]	3.5	3.2	2.9	2.8	W
Plate Input Power	250	375	500	625	W
Plate Output Power	190	280	390	500	W

1. Approximate value.

PULSE MODULATOR SERVICE

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC GRID VOLTAGE	-400	VOLTS
PEAK PLATE CURRENT	6.0	AMPERES
PULSE DURATION	(See Derating Chart)	
DUTY FACTOR	(See Derating Chart)	
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION

Plate Voltage	6000	Vdc
Screen Voltage	750	Vdc
Grid Voltage	-275	Vdc
Peak Drive Voltage [1]	280	v
Peak Plate Current	3.5	a
Peak Screen Current [1]	0.4	a
Peak Input Power	21.0	kW
Peak Output Power	17.5	kW
Peak Output Voltage	5000	kv
Pulse Duration	250	μs
Duty Factor	0.005	

1. Approximate value .

RF POWER AMPLIFIER

Class B or C, Grid and Screen Pulsed

MAXIMUM RATINGS		
DC PLATE VOLTAGE	5500	VOLTS
PEAK DC SCREEN VOLTAGE	1000	VOLTS
DC GRID VOLTAGE	-250	VOLTS
PEAK PLATE CURRENT [1]	6.0	AMPERES
PULSE DURATION	(See Derating Chart)	
DUTY FACTOR	(See Derating Chart)	
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Peak anode current may be considered as average during the pulse and should be limited to 6.0 amperes. With a pulse length longer than 80 μs, or a duty factor higher than 0.0016, peak current should be reduced in accordance with the data shown on the Derating Chart for Anode Current. For longer pulse duration or larger duty factor, consult EIMAC Division of Varian.

TYPICAL OPERATION (Frequencies to 500 MHz)
Class B, Grounded Grid (Measured Values)

Plate Voltage	5500	Vdc
Screen Voltage (Pulsed)	1000	v
Grid Voltage	-200	Vdc
Peak Grid Voltage[2]	255	v
Peak Plate Current	3.5	a
Peak Driving Power [2]	1000	w
Peak Output Power (Useful)	10	kW
Pulse Duration	250	μs
Duty Factor	0.005	

2. Approximate value .

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	2.3	3.0	A
Cathode Warmup Time	30	---	sec.
Interelectrode Capacitances [1] (Grounded Grid Connection)			
Input	12.0	16.0	pF
Output	3.90	4.35	pF
Feedback	---	0.01	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MOUNTING - The 8590/4CPX250K may be mounted in any position. The concentric arrangement of the electrode terminals permits the use of the tube in coaxial line or cavity-type circuits to advantage. Connections to the contact surfaces should be made by means of spring finger collets which have sufficient pressure to maintain a good electrical contact at all fingers. Points of electrical contact should be kept clean and free of oxidation to minimize rf losses.

HEATER - The rated heater voltage for the 8590/4CPX250K is 6.0 volts, as measured at the base of the tube, and variations should be restricted to plus or minus 0.3 volt for long tube life and consistent performance. At frequencies above approximately 300 MHz under Class C Telegraphy conditions, it may be necessary to reduce heater voltage to compensate for rf transit-time heating of the cathode. This type of back-heating is a function of frequency, grid current, grid bias, anode current, duty cycle, and circuit design and adjustment. The following heater operation voltages are recommended for straight-through CW amplifier operation:

Frequency (MHz)	Heater Voltage
300 or lower	6.00
301 to 400	5.75
401 to 500	5.50

COOLING - Sufficient forced-air cooling must be provided to maintain the anode core and seal temperatures within maximum ratings. Special care must be observed to insure that there is adequate cooling in the area of the coaxial filament and grid terminals. With an anode dissipation of 250 watts and an incoming air temperature of 50°C at sea level, a minimum air flow of 4.8 cfm must be passed through the anode cooler, with a resultant pressure drop of approximately 0.25 inch of water. Air should normally be directed in a base-to-anode direction in order to minimize base cooling problems. In cases where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial. Air flow should be applied before or simultaneously with the application of electrode voltages (including heater voltage), and may be removed simultaneously with them.

CATHODE WARMUP TIME - Heater voltage should be applied for a minimum of 30 seconds before the application of other electrode voltages to allow proper conditioning of the cathode surface.

CATHODE OPERATION - The oxide-coated unipotential cathode must be protected against excessively high emission current. The DERATING CHART FOR ANODE CURRENT shows the current capability of the 8590/4CPX250K anode at various pulse durations and duty factors. To use this chart, enter with pulse duration and note the intersection with the desired peak anode current. At this intersection read off the values of maximum duty and/or pulse repetition rate.

Under a given set of operating conditions, element dissipation may limit the maximum permissible duty to a smaller value than anode current considerations alone would dictate. It will usually be found that screen grid dissipation is the limiting factor with large plate voltage swings and that plate dissipation limits the maximum duty with small plate voltage swings.

CONTROL GRID OPERATION - The average power dissipated by the control grid must not exceed two watts. The control grid dissipation can be computed as the product of average grid current, and peak positive grid to cathode voltage.

SCREEN GRID OPERATION - The average power dissipated by the screen grid must not exceed twelve watts. Screen grid dissipation is the product of dc screen voltage, average screen current during the pulse, and duty factor.

The screen grid current may reverse under certain operating conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen grid power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen grid under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator, or an electron tube shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per tube. A series pass tube regulated power supply can be used only when an adequate bleeder resistor is provided. Protection for the screen grid should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

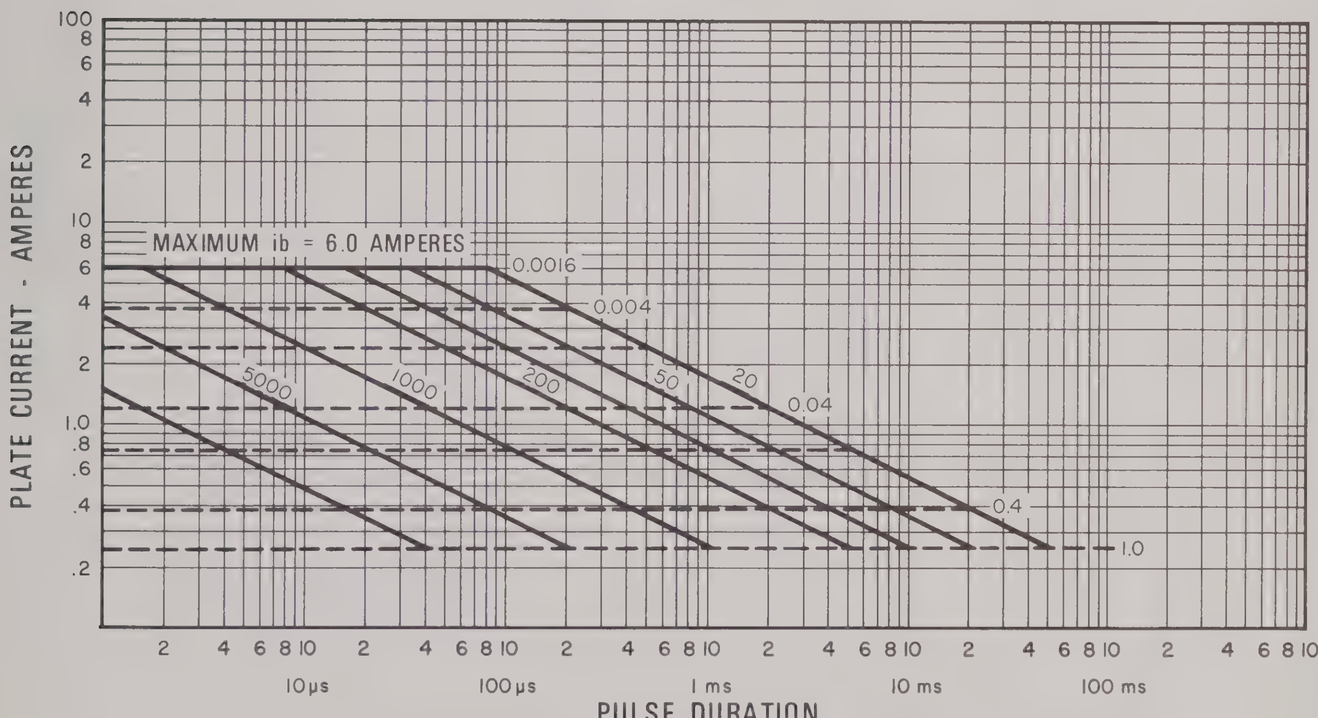
PULSE MODULATOR PLATE OPERATION - Average plate dissipation may be calculated as the product of average plate current during the pulse, minimum anode voltage, and duty factor. Excessive average dissipation is likely to occur with high values of minimum anode voltage. The calculated value of plate dissipation may well be below 250 watts based on a rectangular pulse but excessive dissipation will result if pulse rise and fall times slow down the plate voltage swing and allow plate current to flow for longer periods in the high anode voltage region.

UHF OPERATION - Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustments of bias and/or screen grid voltage to equalize the plate currents. Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that any tube fails.

SPECIAL APPLICATION

If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

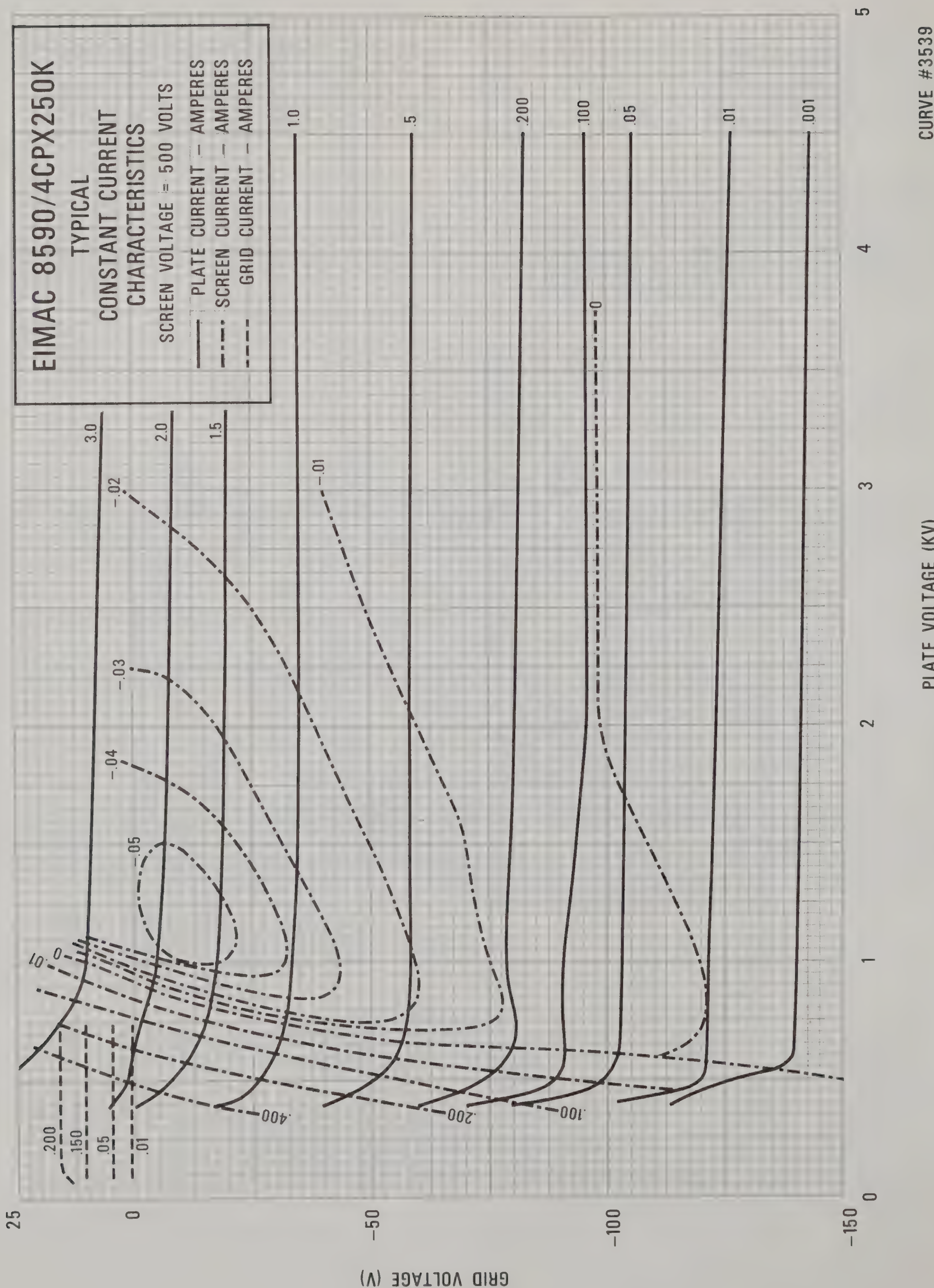


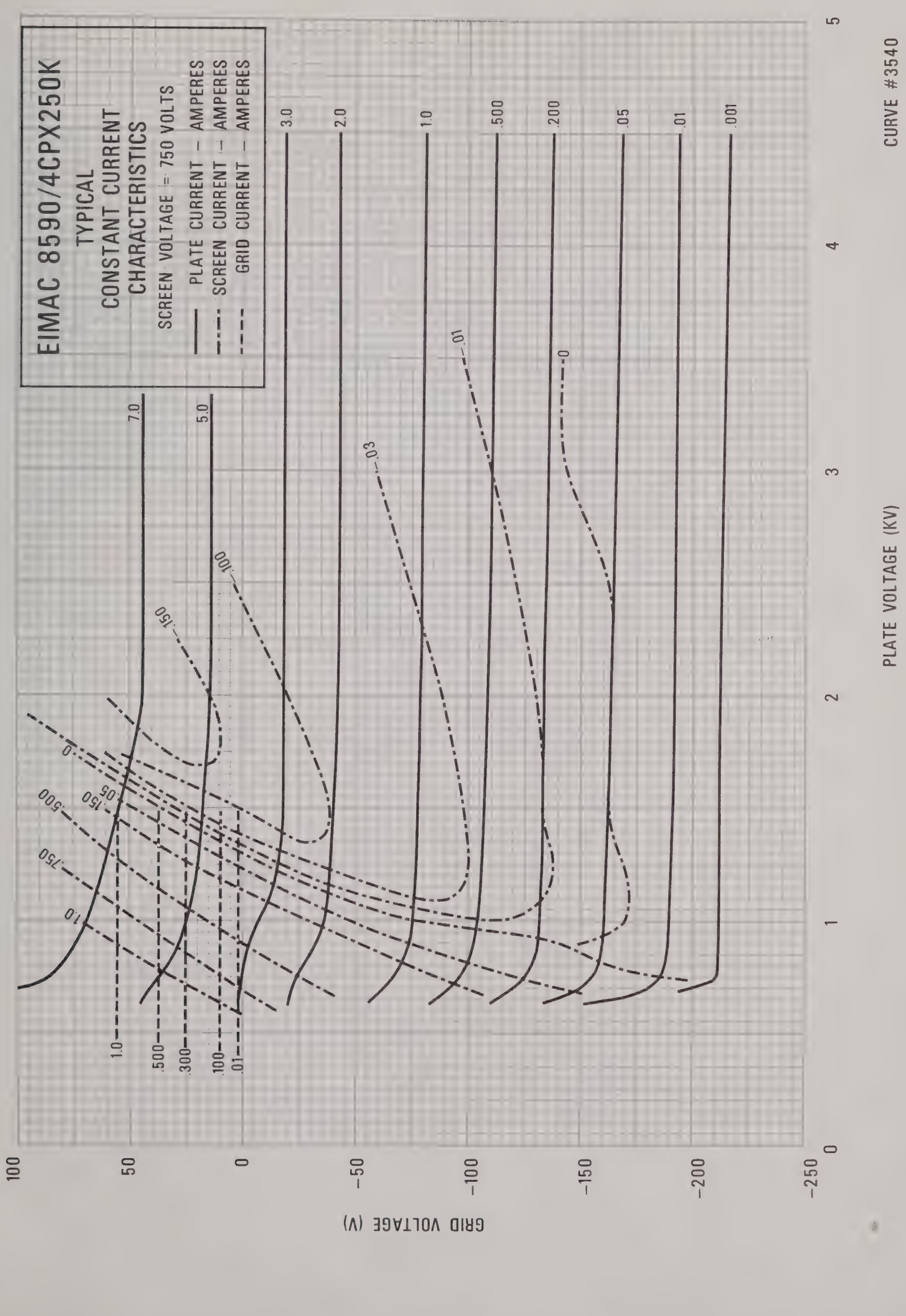
TYPE 8590/4CPX250K – DERATING CHART FOR ANODE CURRENT (AVERAGE DURING PULSE)

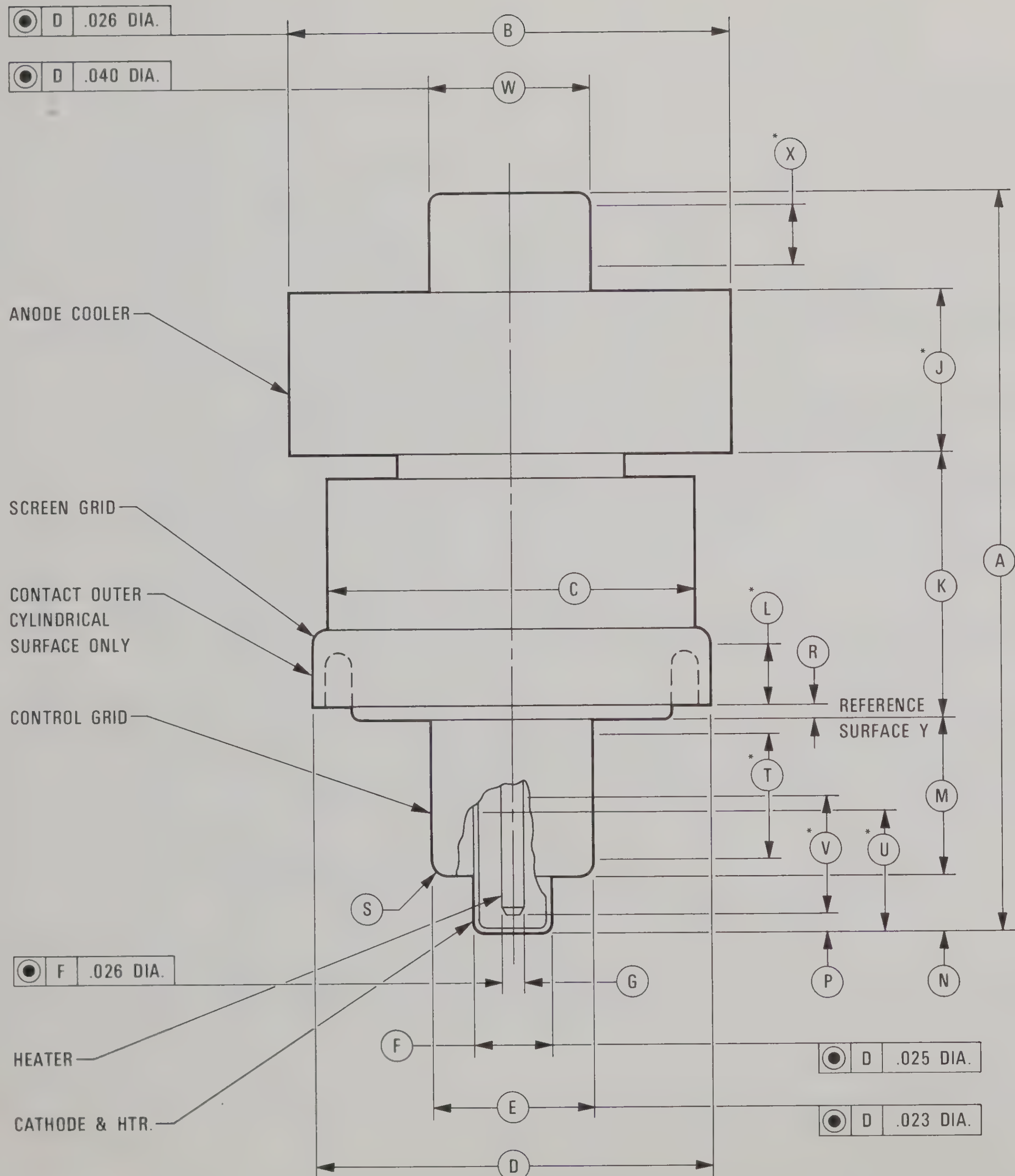
SOLID LINES REPRESENT CONSTANT REPETITION RATES

DASHED LINES REPRESENT CONSTANT DUTIES

DO NOT EXTRAPOLATE ABOVE OR TO THE RIGHT OF BOLD LINES


EIMAC 8590/4CPX250K
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE #3539
3.0
2.0
1.5
1.0
.5
.200
.100
.05
.01
.001
-.01
-.02
-.03
-.04
-.05
0
.01
.400
.200
.100
.150
0
1
2
3
4
5
25
-50
-100
-150


EIMAC 8590/4CPX250K
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #3540
100
50
0
-50
-100
-150
-200
-250
0
1
2
3
4
5
7.0
5.0
3.0
2.0
1.0
.500
.200
.05
.01
.001



DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	2.813	—	71.45
B	1.615	1.640	41.02	41.66
C	—	1.406	—	35.71
D	1.415	1.435	35.94	36.45
E	0.588	0.597	14.94	15.16
F	0.318	0.325	8.08	8.26
G	0.091	0.095	2.31	2.41
J	0.585	0.665	14.86	16.89
K	0.900	0.950	22.86	24.13
L	0.187	—	4.75	—
M	0.520	0.560	13.21	14.22
N	0.235	0.265	5.97	6.73
P	0.032	0.082	0.83	2.08
R	—	0.040	—	0.102
S	—	0.171	—	0.434
T	0.388	—	9.86	—
U	0.406	—	10.31	—
V	0.468	—	11.89	—
W	0.559	0.573	14.20	14.55
X	0.240	—	6.10	—

NOTES:

1. * INDICATES CONTACT SURFACE.

2. THE TUBE WILL BE ROTATED ON DIAMETER D WHEN ECCENTRICITY IS BEING MEASURED.

3. SURFACE Y MUST BE PERPENDICULAR TO THE MEASURING PLATFORM WHEN ECCENTRICITY IS BEING MEASURED.

4. AVERAGE DIAMETER OF E SHALL BE AS NOTED, & MAY BE OUT OF ROUND A TOTAL OF 0.006 (0.15 mm). AVERAGE DIAMETER OF F SHALL BE AS NOTED, AND MAY BE OUT OF ROUND A TOTAL OF 0.006 (0.15 mm).

4CV50,000E

Eimac®

TECHNICAL DATA

VAPOR COOLED
POWER TETRODE

The EIMAC 4CV50,000E is a ceramic/metal, vapor-cooled power tetrode intended for use at the 50 to 100 kilowatt output power level. This tube is characterized by low input and feedback capacitances and low internal lead inductances. A rugged mesh thoriated tungsten filament provides adequate emission over the long operating life. It is recommended for use as a class C rf amplifier or oscillator, a class AB rf linear amplifier or a class AB push-pull af amplifier or modulator. The 4CV50,000E is also useful as a plate and screen modulated class C rf amplifier. The vapor cooled anode is rated at 50 kilowatts dissipation.

Shown with boiler removed.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Mesh Thoriated Tungsten	
Voltage	12.0 ± 0.6 V
Current, at 12.0 volts	215 A
Amplification Factor (Average)	
Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)	
Input	310 pF
Output	52 pF
Feedback	0.7 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:	
Length (less boiler)	11.500 in; (292.1 mm)
Diameter	9.531 in; (241.0 mm)
Net Weight (less boiler)	31.5 lb; (14.3 kg)
Operating Position	Vertical, base down
Maximum Operating Temperature:	
Ceramic/Metal Seals and terminals	250°C
Cooling	Vapor and Forced Air
Base	Special
Recommended Air System Socket	EIMAC SK-2000 Series
Recommended Boiler	EIMAC BR-700 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions.

Plate Voltage	10.0	kVdc
Screen Voltage	1.8	kVdc
Grid Voltage [1]	-260	Vdc
Zero-Signal Plate Current	3.4	Adc
Single Tone Plate Current	9.14	Adc
Peak rf Grid Voltage [2]	230	v
Resonant Load Impedance	600	Ω
Plate Dissipation	35	kW
Plate Output Power	57	kW

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	15.0	15.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-800	-800	Vdc
Plate Current	9.0	11.5	Adc
Screen Current [1]	0.9	0.83	Adc
Grid Current [1]	125	160	mAdc
Peak rf Grid Voltage [1]	880	925	v
Calculated Driving Power [1]	110	150	W
Plate Dissipation	25	36	kW
Plate Output Power	110	137	kW
Resonant Load Impedance	820	615	Ω

1. Approximate value

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION [1]	33,000	WATTS
SCREEN DISSIPATION [2]	1,500	WATTS
GRID DISSIPATION [2]	400	WATTS

1. Corresponds to 50,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	9.0	14.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-600	Vdc
Plate Current	7.41	9.25	Adc
Screen Current [3]	0.69	1.15	Adc
Grid Current	0.333	0.833	Adc
Peak af Screen Voltage [3] (100% modulation)	750	750	v
Peak rf Grid Voltage [3]	750	820	v
Calculated Driving Power	250	685	W
Plate Dissipation	12.5	21.5	kW
Plate Output Power	54.2	110	kW

3. Approximate value .

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	15.0	kVdc
Screen Voltage	1.25	kVdc
Grid Voltage [1/3]	-280	Vdc
Zero-Signal Plate Current	5.0	Adc
Max. Signal Plate Current	18.6	Adc
Max. Signal Screen Current [1]	0.6	Adc
Peak af Grid Voltage [2]	275	v
Peak Driving Power	0	w
Max. Signal Plate Dissipation [2]	41.7	kW
Plate Output Power	195	kW
Load Resistance (plate to plate)	1870	Ω

1. Approximate value.
2. Per tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 12.0 volts	200	230	A
Interelectrode Capacitances (grounded cathode connection)			
Input	290	330	pF
Output	47.0	57.0	pF
Feedback	---	1.0	pF
Interelcctrode Capacitances (grounded grid connection)			
Input	130	150	pF
Output	47.0	57.0	pF
Feedback	---	0.5	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CV50,000E must be operated with its axis vertical. The base of the tube must be down.

SOCKET - The EIMAC sockets type SK-2000 series are recommended for use with the 4CV-50,000E.

COOLING - Cooling is accomplished by immersing the anode in the distilled water filled EIMAC boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, to be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system, it is extremely unlikely that the anode surfaces will ever exceed 110°C at full dissipation ratings.

The water in the boiler must be maintained at a constant level which may be accomplished automatically in an EIMAC vapor cooling system. Condensate from the condenser is returned to the boiler to maintain a constant coolant level. Any losses or drops in coolant level are sensed and makeup water enters the boiler from the reservoir. When the proper level is reached the flow from the reservoir is stopped automatically. A switch is energized when the reservoir water level drops to a low level. This switch may be used to shut down the equipment or activate an alarm.

Air cooling of the tube base is required whenever filament voltage is applied. A minimum air flow of 100 cfm should be ducted toward the center of the EIMAC SK-2000 socket from a blower or fan. Pressure drop through the SK-2000 socket is approximately 0.5 inches of water. The air system must be capable of supplying 100 cfm into this head.

The water used as a coolant in the vapor phase cooling system is continuously distilled. It is imperative that the resistivity of the water be maintained above 200,000 ohms/cm^3. The entry of any contaminator to the system must be prevented. The use of any lead bearing alloys such as brass or soft/solder in fabrication of the cooling system must be avoided since steam leaches out the lead, contaminating the coolant.

Suitable materials for a cooling system are copper, hard solder, and polypropylene. Any contamination of the water causes leakage current to flow through the water supply lines to ground. When the resistivity is low this leakage current power will cause boiling in the lines, interfering with the proper operation of the system.

The user must be prepared to flush the system on initial startup to purge any contamination which may have entered the components during shipment or assembly.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the socket with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 4CV-50,000E is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CV50,000E by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CV50,000E. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in age slightly higher than the point at which performance appears to deteriorate. This point should be periodically checked to maintain proper operation.

GRID OPERATION - The 4CV50,000E control grid is rated at 400 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN OPERATION - The power dissipated by the screen grid must not exceed 1500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CV50,000E may exhibit reversed screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed.

PLATE DISSIPATION - The plate dissipation of 50 kilowatts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV50,000E is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 33,300 watts.

HIGH VOLTAGE - Normal operating voltages used with the 4CV50,000E are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CV50,000E, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

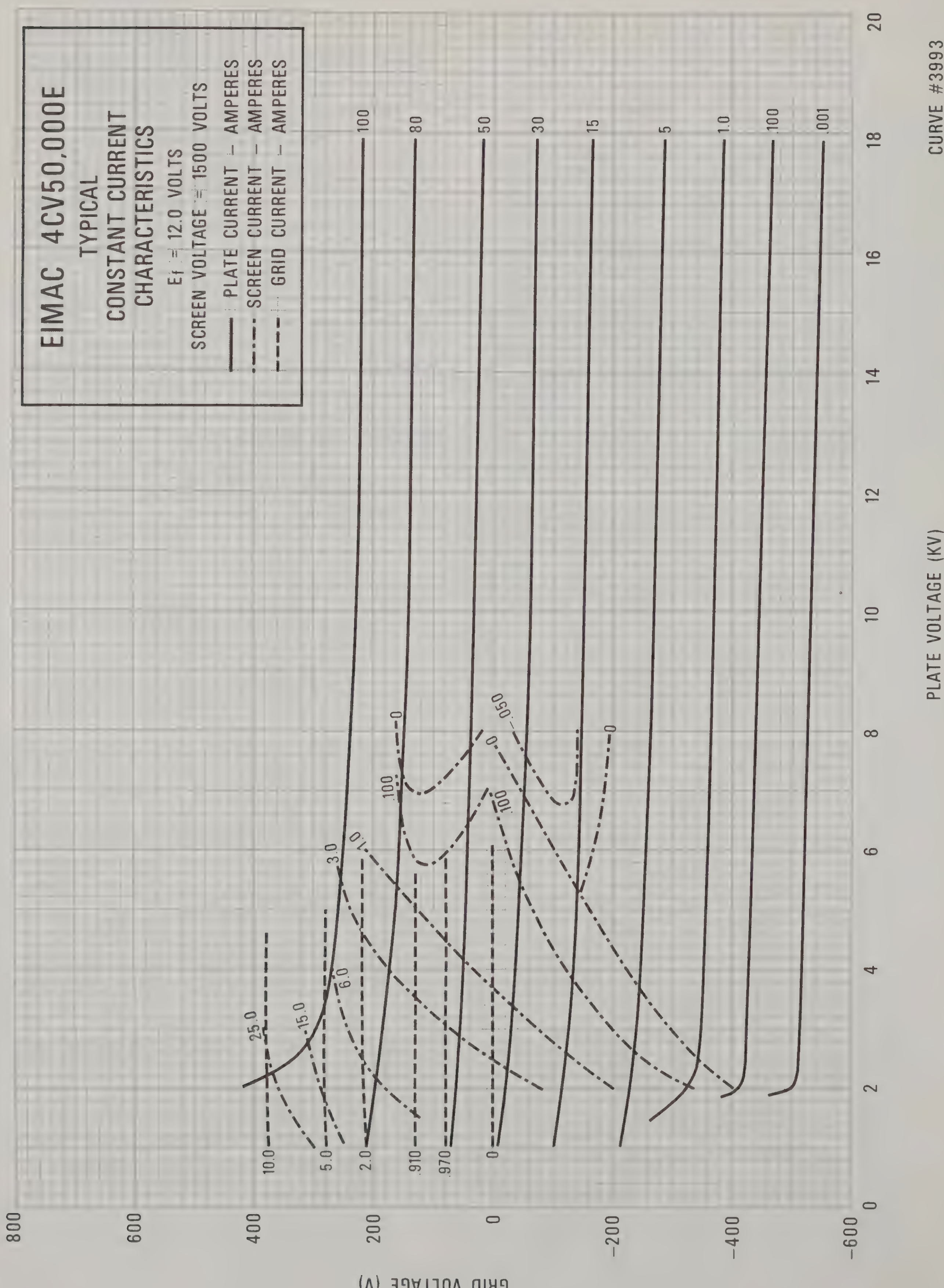
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CV-50,000E, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry --- the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate overcurrent interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltages.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc is recommended.

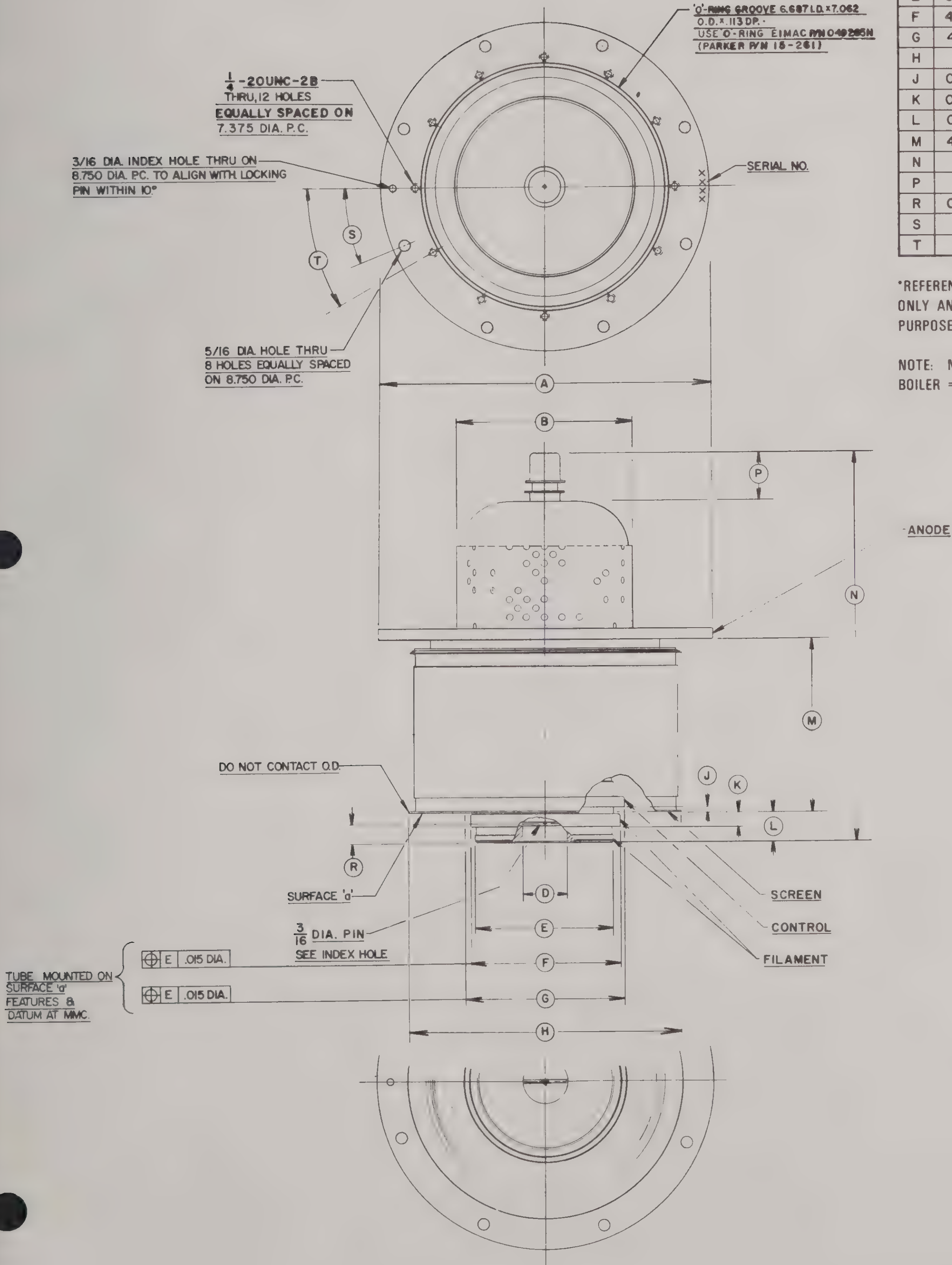
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


EIMAC 4CV50,000E
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ef = 12.0 VOLTS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE #3993

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.468	9.531	240.49	242.09
B	5.000	5.250	127.00	133.35
D	1.250	1.280	31.75	32.51
E	3.865	3.885	98.17	98.68
F	4.240	4.260	107.70	108.20
G	4.490	4.510	114.05	114.55
H	7.750*		196.85*	
J	0.069	0.149	1.75	3.78
K	0.382	0.462	9.70	11.73
L	0.797	0.922	20.24	23.42
M	4.875	5.000	123.83	127.00
N	11.342*		288.09*	
P	1.411*		35.84*	
R	0.469	0.531	11.91	13.49
S	22 1/2°*		22 1/2°*	
T	30°*		30°*	

*REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

NOTE: NOMINAL OVERALL HEIGHT WITH BOILER = 13.0 INCHES (330.2 mm).



TECHNICAL DATA

8170W
4CX5000R

RADIAL-BEAM
POWER TETRODE

The EIMAC 8170W/4CX5000R is a compact, high-power, ceramic/metal tetrode. It is directly interchangeable with the 8170/4CX5000A but incorporates more rugged internal construction features, including a sturdy mesh cathode, which allows it to meet demanding vibration and shock specifications.

The 8170W/4CX5000R is useful up to 110 Mc and is recommended for use as a radio-frequency linear amplifier, a Class-AB audio amplifier, or a Class-C power amplifier or plate-modulated amplifier.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	7.5 ± 0.37 V
Current, at 7.5 volts	75 A

Amplification Factor (Average):

Grid to Screen	4.5

Direct Interelectrode Capacitance (grounded filament)[2]

Cin	115 pF
Cout	20 pF
Cgp	0.7 pF

Direct Interelectrode Capacitance (grounded grid)[2]

Cin	53 pF
Cout	22.5 pF
Cpk	0.10 pF

Frequency of Maximum Rating:

CW	100 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:

Length	9.125 in; 231.77 mm
Diameter	4.938 in; 125.43 mm
Net Weight	9.5 lb; 4.31 kg
Operating Position	Axis vertical, base up or down

Maximum Operating Temperature:	
Ceramic/Metal Seals or Anode Core	250°C
Cooling	Forced Air
Base	Special concentric
Recommended Air System Socket	SK-300 or SK-300A
Recommended (Air) Chimney	SK-306

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN
Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	6000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION (Frequencies to 100 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	7500	Vdc
Screen Voltage	1250	Vdc
Grid Voltage [1]	-300	Vdc
Zero-Signal Plate Current	0.50	Adc
Single-Tone Plate Current	1.90	Adc
Single-Tone Screen Current [2]	0.20	Adc
Peak rf Grid Voltage [2]	300	v
Plate Dissipation	4200	W
Single-Tone Plate Output Power	10,000	W

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	5000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION (Frequencies to 100 MHz)

Plate Voltage	6500	Vdc
Screen Voltage	750	Vdc
Grid Voltage	-350	Vdc
Plate Current	2.30	Adc
Screen Current [1]	0.20	Adc
Grid Current [1]	0.05	Adc
Measured Driving Power [1]	100	W
Useful Output Power	10,000	W

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN
Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION [1]	3500	WATTS
SCREEN DISSIPATION [2]	250	WATTS
GRID DISSIPATION [2]	75	WATTS

1. Corresponds to 5000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 100 MHz)

Plate Voltage	5000	Vdc
Screen Voltage	500	Vdc
Grid Voltage	-400	Vdc
Plate Current	1.40	Adc
Screen Current [1]	0.26	Adc
Grid Current [1]	0.05	Adc
Peak af Screen Voltage [1] (100% modulation)	450	v
Peak rf Grid Voltage [1]	520	v
Calculated Driving Power	25	W
Plate Dissipation	1200	W
Plate Output Power	5800	W

1. Approximate value

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	6000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

1. Approximate value.
2. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	5000	6000	7000	Vdc
Screen Voltage	1250	1250	1250	1250	Vdc
Grid Voltage [1/4]	-270	-280	-310	-325	Vdc
Zero-Signal Plate Current	1.25	1.00	0.83	0.70	Adc
Max. Signal Plate Current	5.10	4.40	4.25	3.65	Adc
Max. Signal Screen Current[1]	0.35	0.33	0.30	0.24	Adc
Peak af Grid Voltage[2]	250	240	270	235	v
Max. Signal Plate Dissipation[1]	4200	4200	4200	4200	W
Plate Output Power	11,500	13,500	17,000	17,500	W
Load Resistance (plate to plate)	1500	2370	2940	4100	Ω

3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	73	78	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	108	122	pF
Cout	18	23	pF
Cgp	---	1.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	48	58	pF
Cout	19	24	pF
Cpk	---	0.16	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX5000R must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-300A Air-System Socket is designed especially for the concentric base terminals of the 4CX5000R. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-306, into the anode cooling fins. The SK-300 socket may be used instead of the SK-300A, but its use will result in a slightly less efficient cooling system at high dissipation levels.

COOLING - The maximum temperature rating for the external surfaces of the 4CX5000R is 250°C. Sufficient forced-air circulation must be

provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Sea level air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below (for operation below 30 megacycles).

	SK-300A Socket		SK-300 Socket	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of water)	Air Flow (CFM)	Pressure Drop (Inches of water)
2000	75	0.4	75	0.4
3000	105	0.7	100	0.7
4000	145	1.1	135	1.2
5000	190	1.5	165	1.8
6000	230	2.0	200	2.5

Since the power dissipated by the filament represents about 560 watts and since grid-plus screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation

At higher altitudes, higher frequencies, or higher ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using maximum rated temperatures as the criteria for satisfactory cooling.

IMPACT AND VIBRATION - The 4CX5000R is designed to operate under shock and vibration that might disable a less rugged tube. Up to 50 g of impact of 11 millisecond duration can be sustained and vibratory acceleration up to 5 g from 14 to 200 Hz and 2 g from 200 to 500 Hz will not ordinarily injure the tube unless prolonged. Production tubes are subjected to testing to insure this ruggedness.

ELECTRICAL

FILAMENT VOLTAGE - The rated filament voltage for the 4CX5000R is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

GRID DISSIPATION - The 4CX5000R control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. Grid Dissipation is approximately the product of dc grid current and peak positive grid voltage. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

SCREEN DISSIPATION - The power dissipated by the screen of the 4CX5000R must not exceed 250 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX5000R is 5000 watts for most applications but for audio and SSB amplifier applications, the maximum allowable dissipation is 6000 watts. Plate dissipation may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

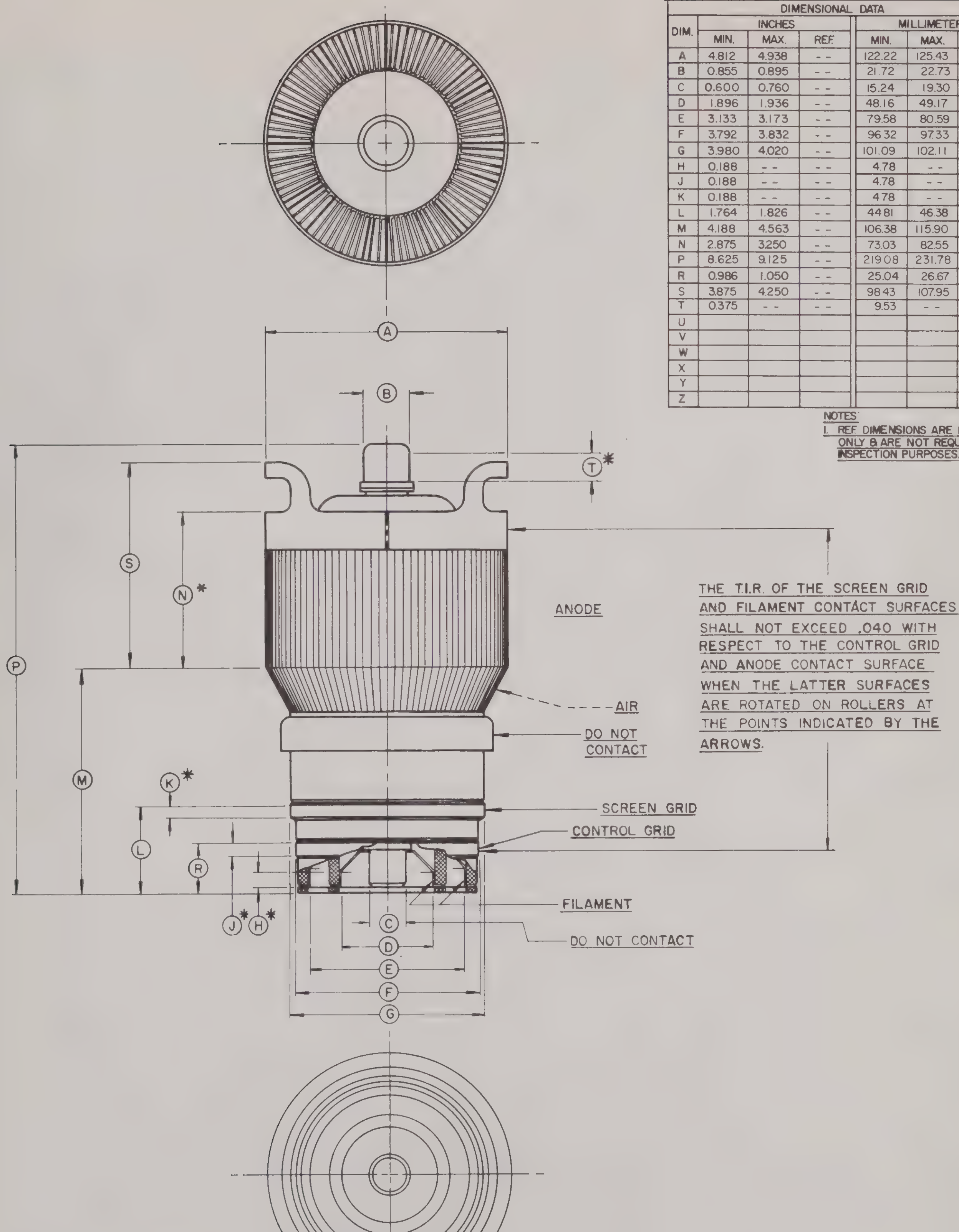
When the 4CX5000R is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 3500-watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - The 4CX5000R operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

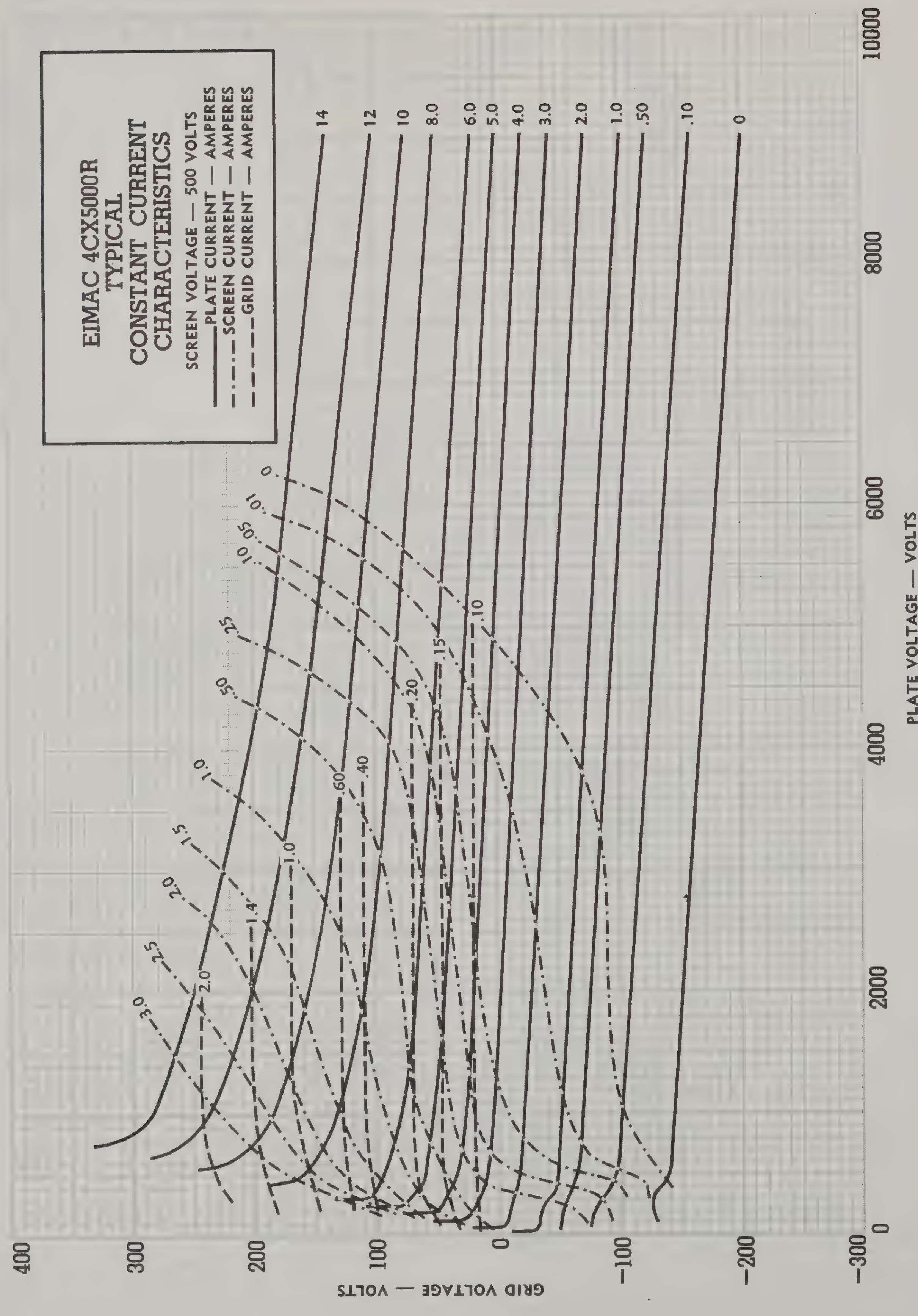
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

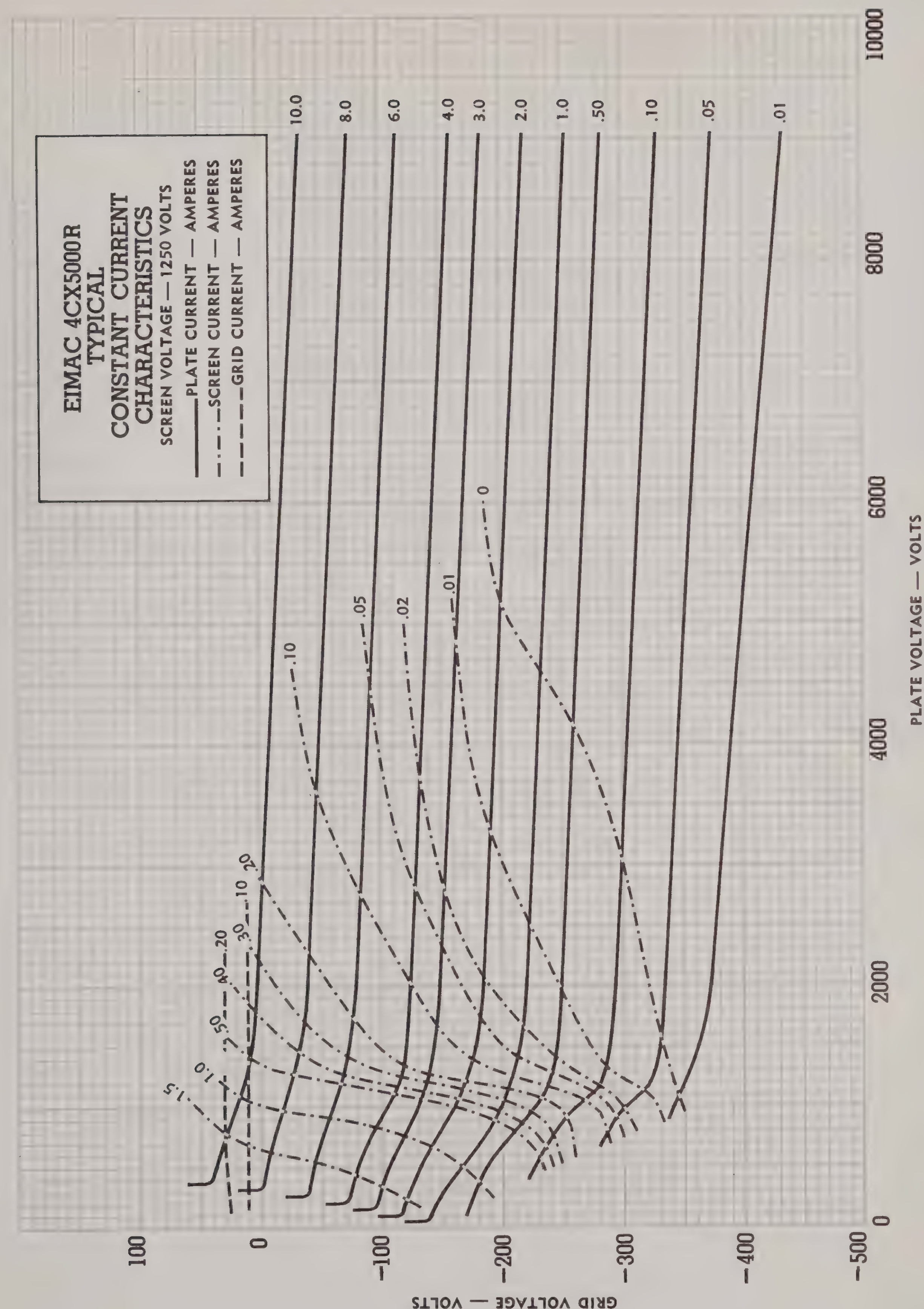
DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.812	4.938	- -	122.22	125.43	- -
B	0.855	0.895	- -	21.72	22.73	- -
C	0.600	0.760	- -	15.24	19.30	- -
D	1.896	1.936	- -	48.16	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
G	3.980	4.020	- -	101.09	102.11	- -
H	0.188	- -	- -	4.78	- -	- -
J	0.188	- -	- -	4.78	- -	- -
K	0.188	- -	- -	4.78	- -	- -
L	1.764	1.826	- -	44.81	46.38	- -
M	4.188	4.563	- -	106.38	115.90	- -
N	2.875	3.250	- -	73.03	82.55	- -
P	8.625	9.125	- -	219.08	231.78	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.875	4.250	- -	98.43	107.95	- -
T	0.375	- -	- -	9.53	- -	- -
U						
V						
W						
X						
Y						
Z						

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



✱ CONTACT SURFACE
ALL DIMENSIONS IN INCHES


EIMAC 4CX5000R
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
PLATE VOLTAGE — VOLTS
GRID VOLTAGE — VOLTS


EIMAC 4CX5000R
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 1250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
PLATE VOLTAGE — VOLTS
GRID VOLTAGE — VOLTS

TECHNICAL DATA

SK-306
SK-316

AIR-SYSTEM CHIMNEYS

SK-306 Chimney shown with 4CX5000A and SK-300 socket

The SK-306 and SK-316 Air-System Chimneys are intended for use with the tube and socket combinations listed below. They are used to direct cooling air to the tube's anode cooling fins after it has been forced through the companion Air-System Socket.

MATERIALS

These chimneys are molded from a gray thermosetting polyester premix compound.

INSTALLATION

The SK-306 mounts above the chassis or plenum and is secured by the eight mounting screws that secure the SK-300 or SK-300A socket.

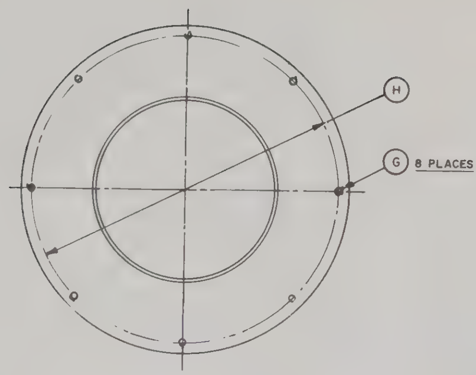
The SK-316 mounts above the chassis with four separate mounting screws on 8-15/16'' diameter pitch circle.

CHIMNEY/TUBE/SOCKET COMBINATIONS

CHIMNEY	TUBE	SOCKET
SK-306	8170/4CX5000A 8909/4CX5000J 8170W/4CX5000R	SK-300
SK-316	8910/4CX15,000J 8281/4CX15,000A	SK-300A

Net Weight .... SK-306 — 5.5 ounces
SK-316 — 11 ounces

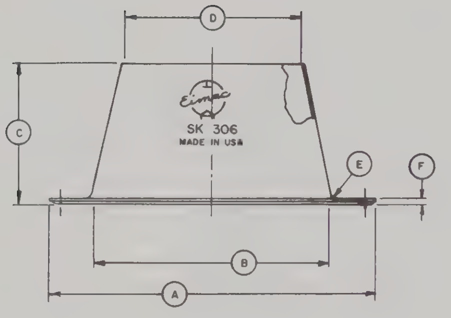
Printed in U.S.A.

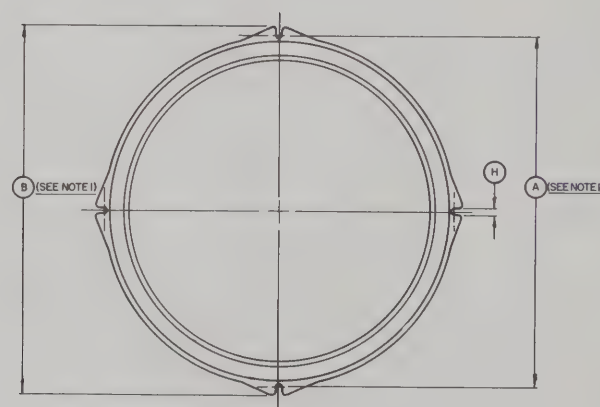


DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.218	8.281		208.74	210.34	
B	6.687	6.812		169.85	173.02	
C	3.400	3.562		86.36	90.47	
D	4.890	4.960		124.21	125.98	
E			.125			3.17
F	.062	.187		1.57	4.75	
G	.136	.176		3.45	4.47	
H			7.750			196.85

NOTES:

1. REF DIMS ARE FOR INF ONLY AND ARE NOT REQD FOR INSP PURPOSES.

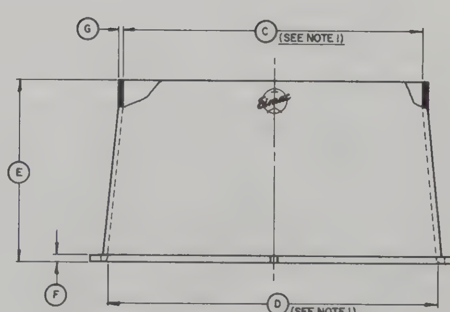




DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.900	8.985		226.06	228.22	
B	9.262	9.389		235.25	238.48	
C	7.560	7.652		192.02	194.36	
D	8.340	8.440		211.84	214.38	
E	4.606	4.706		116.99	119.53	
F	.156	.218		3.96	5.54	
G	.062	.125		1.57	3.17	
H	.140	.200		3.56	5.08	

NOTES:

1. DIAMETERS NOTED ARE AVERAGE OF DIA. MEASUREMENTS TAKEN 90 DEGREES APART WITH PART UNRESTRAINED.
2. MAX. OPERATING TEMPERATURE 125 DEGREES C.
3. MATL: POLYESTER PRE-MIX COMP. (GREY) FIBERGLASS.



TECHNICAL DATA

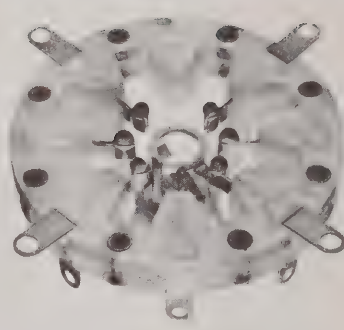
SK-650
SK-655

AIR-SYSTEM SOCKET

The Eimac SK-650 is one of the Air-System Sockets recommended for use with those tubes listed at the bottom of the page, or other tube types having the same special nine-pin base, when a compact, low-cost, special purpose socket is required. When this socket is used, connection is made to each of the tube electrodes except the anode.

The SK-655 Screen By-Pass Capacitor is a separate encapsulated capacitor designed for use with the SK-650 Air-System Socket. When this combination is used, the screen by-pass capacitor can be replaced without troublesome or costly repairs.

Both the SK-650 and the SK-655 are humidity and salt-spray resistant.



SK-650
Air-System Socket

BASE CONNECTIONS

The SK-650 Air-System Socket consists of seven base pin contacting terminals (no contact is made to Pin #5) and a center control-grid terminal. The cathode of the tube is connected to its external circuits by the four even-numbered base pins which, in turn, are connected to the four socket mounting tabs. Connections are made in this manner to minimize the effects of lead inductance. When the SK-650 Air-System Socket is used alone, connection is made to the screen-grid via Pin #1. Control grid contact is accomplished by means of a 6/32″ screw at the center terminal.

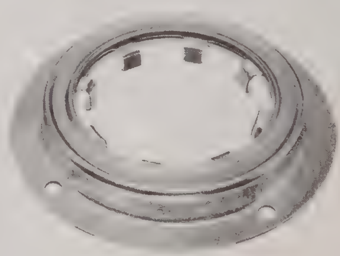
THE SK-655 SCREEN-GRID BY-PASS CAPACITOR

The SK-655 Screen-Grid By-Pass Capacitor is an independent encapsulated capacitor which is mounted to the SK-650 Air-System Socket by the same four socket mounting screws. This is a low-inductance capacitor, 1100 uuf $\pm$ 20%, which provides a short radio-frequency path to ground. The capacitor is hi-voltage breakdown tested at 2000 volts d-c and rated at 1000 volts d-c. When the SK-655 is mounted on a grounded chassis, one side of the screen by-pass capacitor is automatically grounded.

MATERIALS AND FINISHES

In the SK-650 Air-System Socket, the base pin terminals and the four mounting lugs are fabricated of beryllium-copper, heat treated after forming, then silver-plated. The center control-grid terminal is silver-plated brass.

The insulating material, polytrifluorochloroethylene, is chemically inert, non-flammable, will not absorb water or water-vapors and is not affected by acids or alkalies. It will not react to normal solvents except in the case of halogenated compounds which will induce minor dimensional changes. Its physical characteristics are stable over a temperature range of $-196°C$ to $+199°C$ and it is resistant to embrittlement and thermal shock.



SK-655 Screen
By-Pass Capacitor

The SK-655 Screen By-Pass Capacitor has a body, or shell, constructed of silver-plated brass while the eight screen-grid contacting fingers are heat treated, silver-plated beryllium-copper. The capacitor dielectric is silvered-mica and is encapsulated in epoxy resin.

Net Weight of the SK-650 Air-System Socket .... 1.2 ounces

Net Weight of the SK-655 Screen-Grid By-Pass Capacitor .... 1.5 ounces

INSTALLATION

Both the SK-650 Air-System Socket and the SK-655 Screen-Grid By-Pass Capacitor can be mounted to a chassis deck or partition by the four 0.130″ diameter holes provided in each of the assemblies. Both units have holes which are 90° apart and are drilled on 2-17/32″ diameter pitch circle.

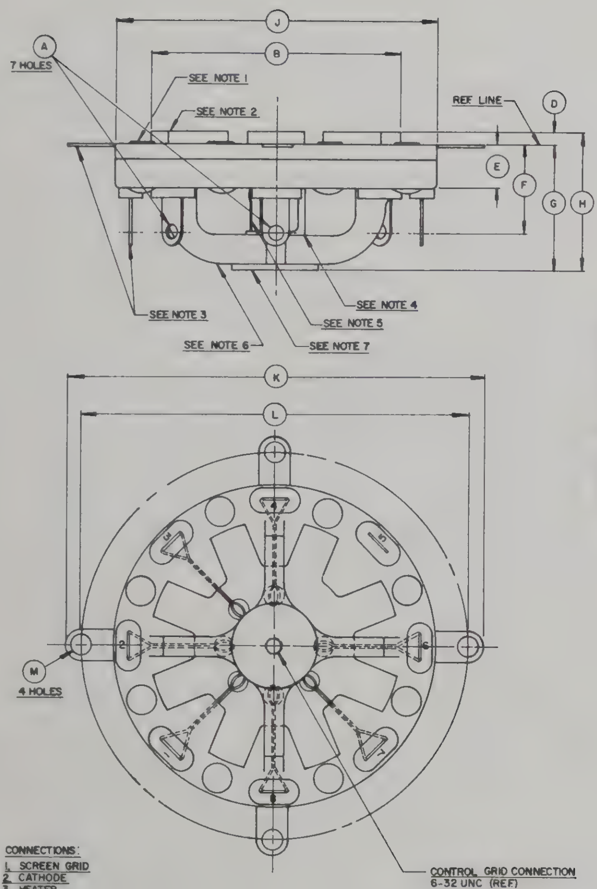
The SK-650 Air-System Socket requires a 2-1/8″ diameter hole to accept the socket body.

TUBE EXTRACTOR

The SK-604 is a spring-steel device useful for inserting and extracting tubes of the type used in the SK-650 Air-System Socket. It is recommended for use where the construction of the equipment makes it difficult or impossible to grasp the tube by hand or when it is necessary to handle the tubes while they are still hot from recent use.

THE SK-650 AIR-SYSTEM SOCKET IS RECOMMENDED FOR USE WITH THE FOLLOWING TUBES:

7034/4CX150A	8621/4CX250FG	8321/4CX350A
7609	7580W/4CX250R	8322/4CX350F
7203/4CX250B	8249/4W300B	8904/4CX350FJ
8957/4CX250BC		

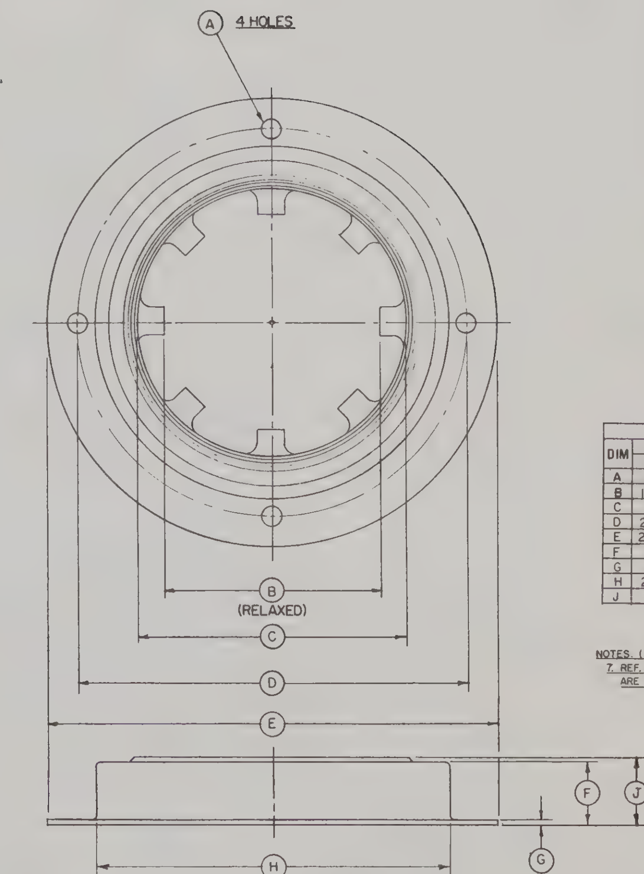


CONNECTIONS:
1. SCREEN GRID
2. CATHODE
3. HEATER
4. CATHODE
5. NO CONNECTION
6. CATHODE
7. HEATER
8. CATHODE

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF
A			.090 D			2.29
B	1.610 D	1.645 D		40.9	41.8	
D	.012	.048		0.30	1.22	
E			.287			7.29
F			.573			14.5
G			.827			21.0
H	.825	.875		20.9	22.2	
J	2.092	2.119		53.1	53.8	
K	2.700	2.792		68.6	70.9	
L	2.510 D	2.551 D		63.7	64.8	
M	.1100	.1200		2.79	3.05	

NOTES:
1. RIVET, 70-30, BRASS
2. RETAINER, KEL-F No. 300
3. BASE PIN CONTACT SPRING, HEAT TREATABLE NON-FERROUS ALLOY
4. CONTROL GRID LEAD KEYWAY, HEAT TREATABLE NON-FERROUS ALLOY.
5. CONTROL GRID LEAD CONTACT, HEAT TREATABLE NON-FERROUS ALLOY.
6. BODY, KEL-F No. 300
7. KEYWAY RIVET, 70-30 BRASS.
8. REF DIMS ARE FOR INFO ONLY AND ARE NOT REQD. FOR INSP. PURPOSES.

SK-650 OUTLINE DRAWING



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN	MAX.	REF.
A	.125	.135		3.17	3.43	
B	1.330	1.390		33.8	35.3	
C			1.702			43.2
D	2.520	2.560		64.0	65.0	
E	2.858	2.891		72.6	73.4	
F	.380	.410		9.65	10.41	
G	.025	.037		0.63	0.94	
H	2.280	2.310		57.9	58.7	
J			.415			10.5

NOTES. (CONT.)
7. REF. DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSP. PURPOSES

NOTES
1. CAPACITY-1100 MMFD. ± 20%.
2. VOLTAGE-2000VDC TEST, 1000 VDC WORKING.
3. DIAMETERS TO BE CONCENTRIC WITHIN .025.
4. CAPACITOR SEALED WITH EPOXY RESIN.
5. SILVER PLATE

SK-655 OUTLINE DRAWING

SK-700 AND SK-710 AIR-SYSTEM SOCKETS

TECHNICAL DATA

The EIMAC SK-700 and SK-710 Air-System Sockets are designed to socket the EIMAC 8167/4CX300A or 8561/4CX300Y. Connections are made to each of the tube electrodes except the anode. An integral screen-grid by-pass capacitor is built into the socket.

SK-700

SK-700

The cathode contacts are insulated from ground.

SK-710

All six of the cathode contacts are connected directly to the metal body.

HEATER CONNECTIONS

In both socket types, one heater contact is connected directly to the metal body.

SK-700 WITH SK-606

SCREEN-GRID BY-PASS CAPACITOR

The capacitor is built into the socket and provides a low-impedance path to ground for screen-grid rf currents. It is tested at 1000 volts dc and rated at 400 volts dc. Capacitance is 1100 picofarads ±20%.

MATERIALS AND FINISHES

The metal shell, or body, of the socket is made of silver-plated brass. The non-ferrous alloy contacts are heat treated after forming and then silver-plated. Three silver-plated brass toe clamps are supplied for mounting purposes.

The socket insulating material is chemically inert, non-flammable, and will not absorb water or water vapor. It is not affected by strong or weak acids or alkalies. It will not react to normal solvents except in the case of halogenated compounds, which will induce minor dimensional changes. Its physical characteristics are stable over a temperature range of —150°C to +275°C and it is resistant to embrittlement and thermal shock.

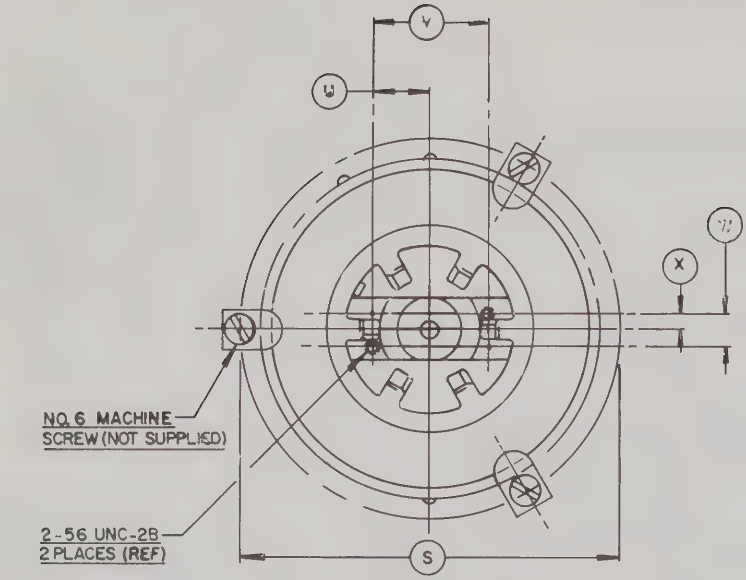
A silvered-mica dielectric is used in the screen-grid by-pass capacitor.

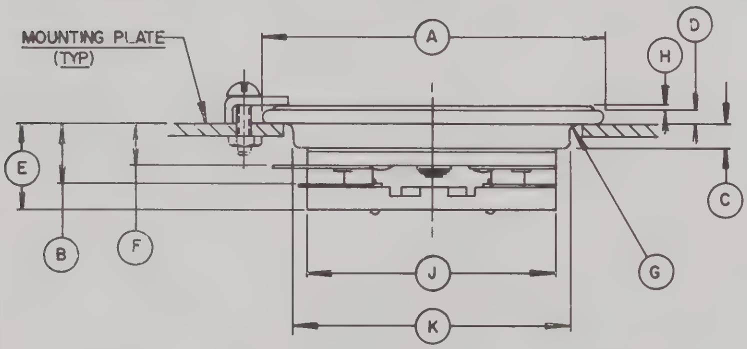
SOCKET, TUBE, AND CHIMNEY

AIR CHIMNEY

The SK-606 is intended to be used with the tube mounted vertically with the anode up. If horizontal mounting or vertical mounting with the anode down is required, means should be provided to retain the chimney. The air chimney is made of high-temperature ceramic and serves to direct the flow of air emerging from the socket into the anode cooling fins. It is recommended that the SK-606 chimney, or its equivalent, be used with each SK-700 or SK-710 socket.

 Printed in U.S.A.

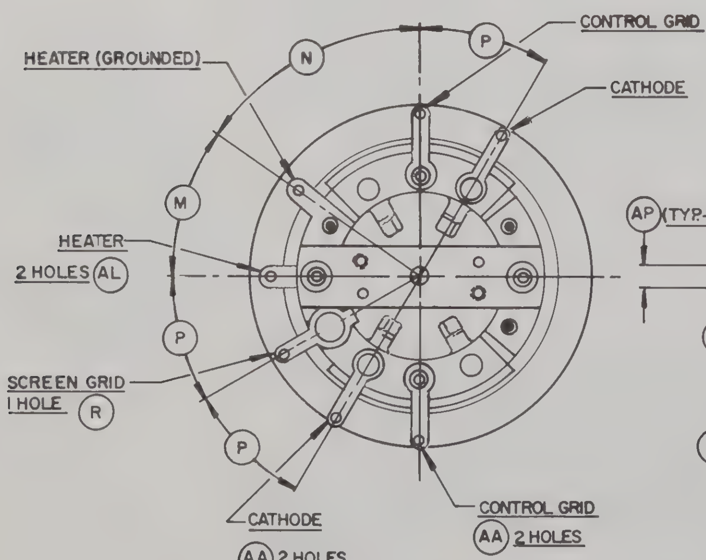


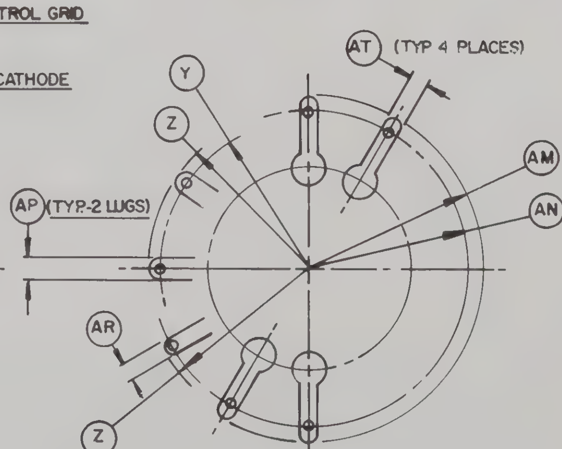


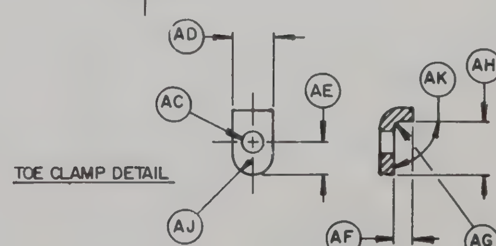
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2 688	2.750		68.27	69 85	
B	.453	.493		11.51	12.52	
C	.175	.207		4.44	5.26	
D	107	147		2.71	3.73	
E	.650	.690		16.51	17.53	
F	.312	.352		7.92	8.94	
G			.031 R			.079R
H	.014	.046		0.35	1.17	
J			2 Dia.			50.4D
K	2.184	2.210		55.47	56.13	
M			35°			35°
N			55°			55°
P			30°			30°
R			.062D			1.57D
S			3.000			76.20
U	.437	469		11.10	11.91	
V	890	.922		22.60	23.42	
W	.234	.266		5.94	6.76	
X	.109	.141		2.77	3.58	
Y			1.203R			3055R
Z			1.313R			33.55R
AA	.080	.085		2.03	2.16	
AC	.142	.146		3.61	3.71	
AD	.292	.332		7.42	8.43	
AE	.292	.332		7.42	8.43	
AF	.105	.145		2.67	3.68	
AG			.062R			1.57 R
AH	.417	.457		10.59	11.61	
AJ	.125 R	.187R		3.17R	4.75R	
AK	80°	100°		80°	100°	
AL			.062 D			1.57 D
AM			1.437 R			36.50R
AN			1.281 R			32.54R
AP			.187			4.75
AR			.125			3.17
AT	.109	.140		2.77	3.55	

NOTES

1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQD. FOR INSP. PURPOSES.
2. TOLERANCES ARE NOT CUMULATIVE.
3. CAPACITANCE - 1100 MMFD ± 20%, VOLTAGE - 1000 VDC, TEST-400 WVDC



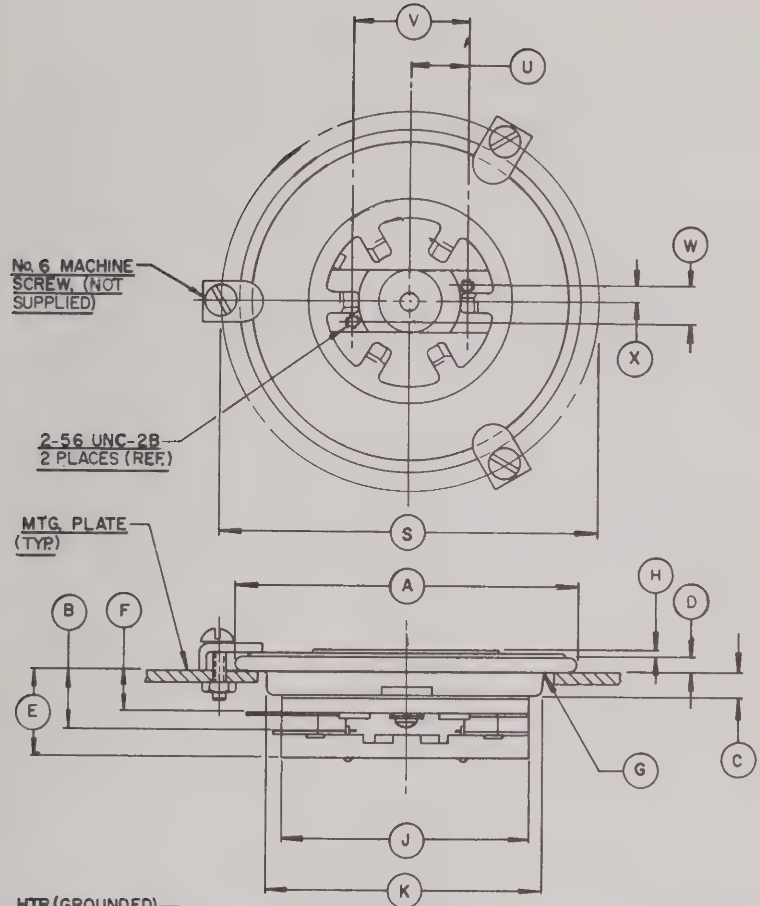


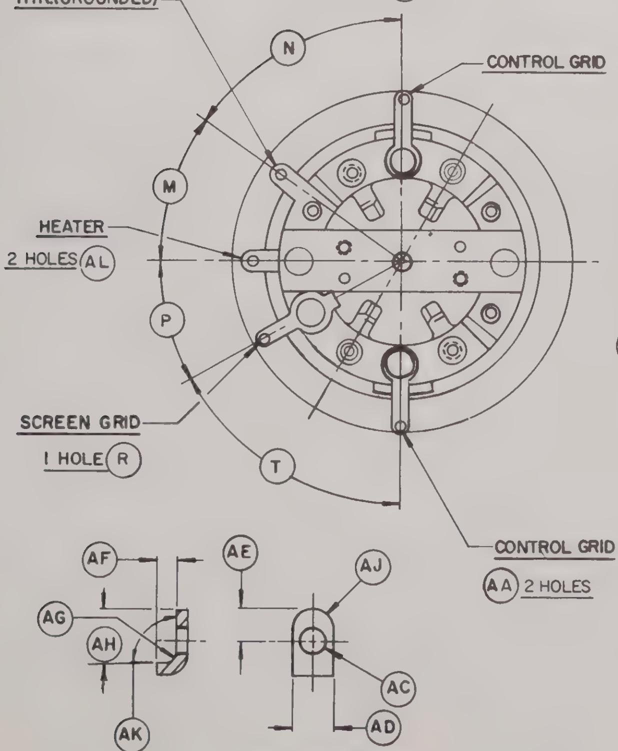


DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.688	2.750		68.27	69.85	
B	.453	.493		11.51	12.52	
C	.175	.207		4.44	5.26	
D	.107	.147		2.71	3.73	
E	.650	.690		16.51	17.53	
F	.312	.352		7.92	8.94	
G			.031R			.079R
H	.014	.046		0.35	1.17	
J			2 Dia.			50.4D
K	2.184	2.204		55.47	55.98	
M			35°			35°
N			55°			55°
P			30°			30°
R			.062D			1.57D
S			3 Dia.			76.20D
T			60°			60°
U	.437	469		11.10	11.91	
V	.890	.922		22.61	23.42	
W	.234	.266		5.94	6.76	
X	.109	.141		2.77	3.58	
Y			1.203R			30.55R
Z			1.312R			33.55R
AA	.080	.085		2.03	2.16	
AC	.142	.146		3.61	3.71	
AD	.292	.332		7.42	8.43	
AE	.292	.332		7.42	8.43	
AF	.105	.145		2.67	3.68	
AG			.062R			1.57R
AH	.417	.457		10.59	11.61	
AJ	.125R	.187R		3.17R	4.75R	
AK	80°	100°		80°	100°	
AL			.062D			1.57D
AM			1.437R			36.50R
AN			1.281R			32.54R
AP			.187			4.75
AR			.125			3.17
AT	.109	.140		2.77	3.55	

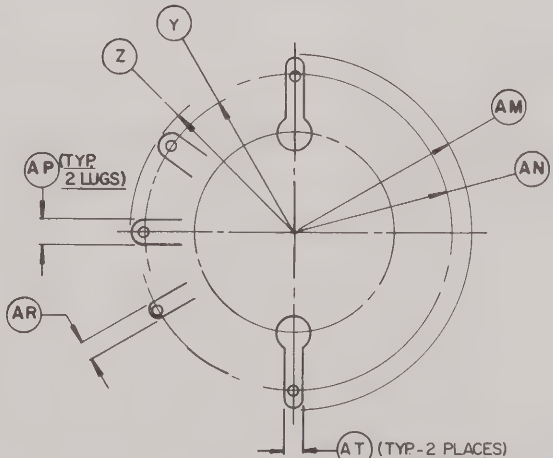
NOTES:

1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQD. FOR INSP. PURPOSES.
2. TOLERANCES ARE NOT CUMULATIVE.
3. CAPACITANCE, 1100 MMFD ±25%, VOLTAGE 1000 VDC TEST, 400 WVDC





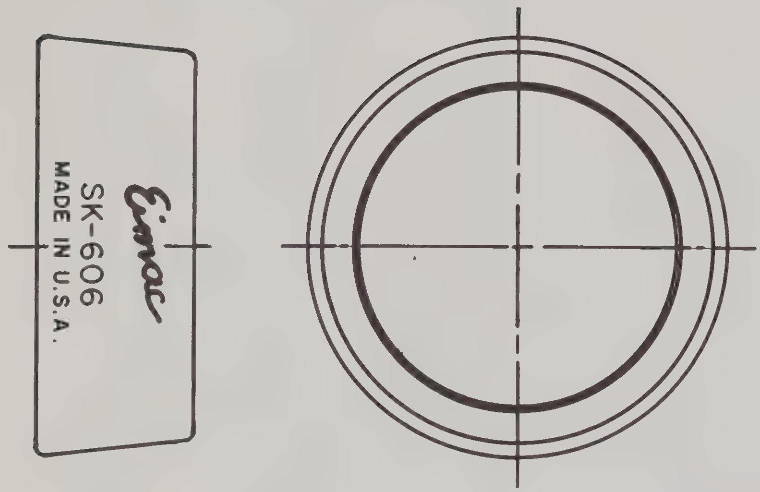
TOE CLAMP DETAIL

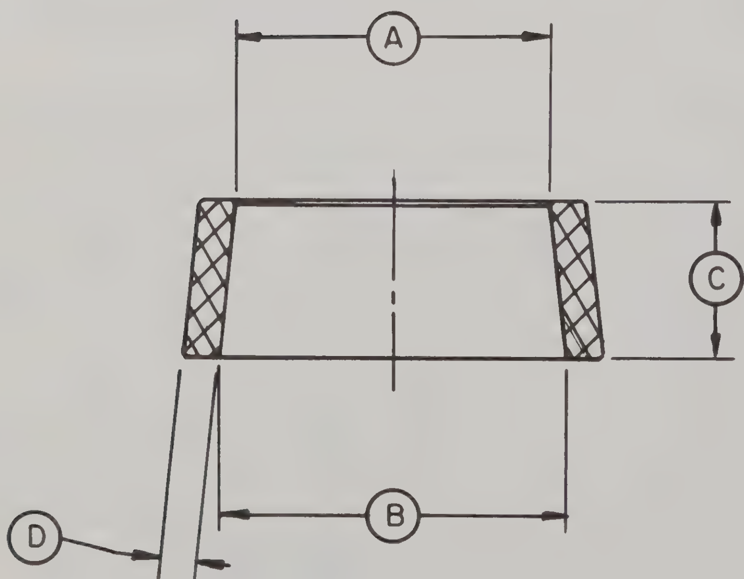


LUG DIMENSIONS (DETAILS OMITTED FOR CLARITY)

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	1.635	1.700	
B	1.781	1.881	
C	.812	.875	
D	.156	.218	





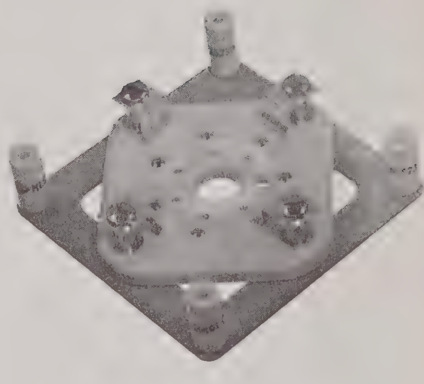
TECHNICAL DATA

SK-2200
SK-2210
AIR SYSTEM SOCKET
SK-2216
AIR CHIMNEY

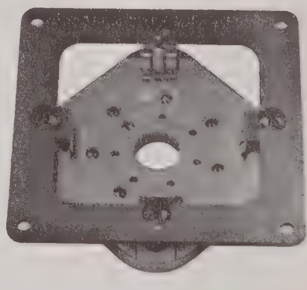
The EIMAC SK-2200 and SK-2210 are air-system sockets recommended for use with the EIMAC 8877/3CX1500A7 triode. A companion chimney is available, which will operate with either socket.

With these sockets, connection is made to each tube element except the anode.

No contacts are grounded on the SK-2200, while the SK-2210 has the grid contacts grounded to the equipment chassis when installed.



SK-2200



SK-2210

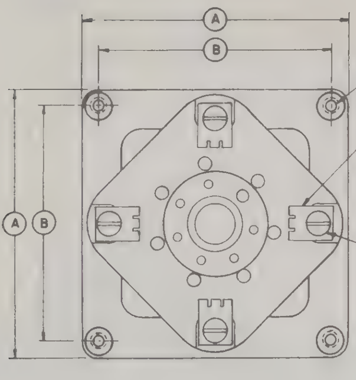
INSTALLATION
The SK-2200 and SK-2210 are designed for under-chassis mounting, and require a 3¼ inch hole through the chassis deck. Each socket is held in place by four 6-32 screws.

AIR CHIMNEY
The SK-2216 chimney is made of low-loss teflon. It is held in place with four toe clamps which are supplied with the chimney.

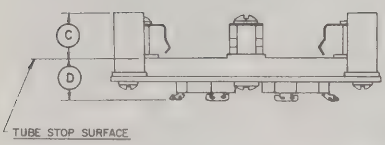
SK-2216

NET WEIGHTS
SK-2200 Socket	4.5oz; 128 gm
SK-2210 Socket	4.0 oz; 113 gm
SK-2216 Chimney	2.0 oz; 56.7 gm

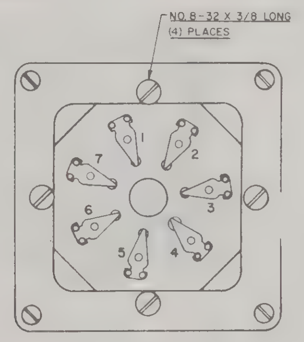
SK-2200/SK-2210



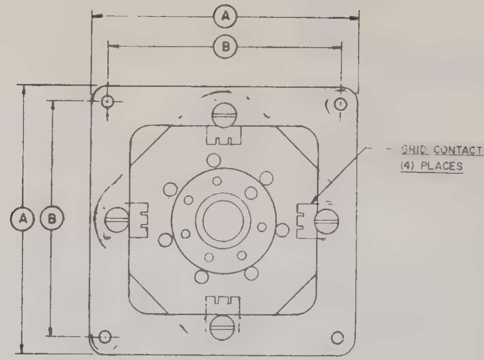
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN	MAX	REF
A	3 373	3413	- -	8567	86 70	- -
B	2 953	2 983	- -	7501	75 77	- -
C	0 500	0 550	- -	1270	13 97	- -
D	- -	0630	- -	- -	16 00	- -

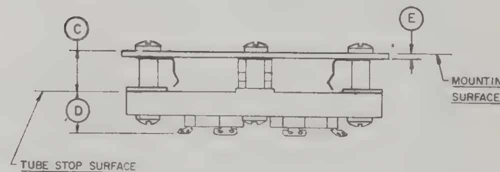


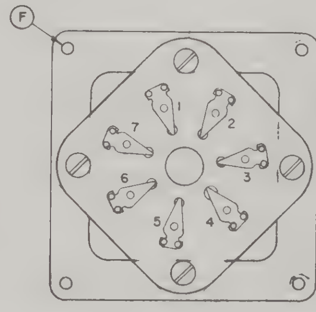
NOTES
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. CONNECTIONS.
   - 1-HEATER
   - 2-CATHODE
   - 3-CATHODE
   - 4-CATHODE
   - 5-HEATER
   - 6-CATHODE
   - 7-CATHODE
3. GRID CONTACTS INSULATED FROM GROUND & OTHER ELEMENTS.



SK-2200 Socket



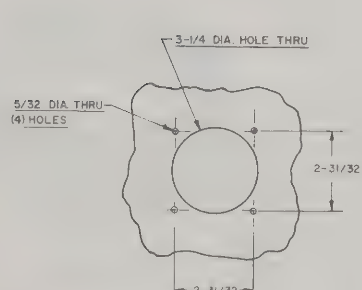




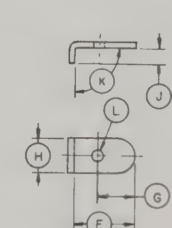
SK-2210 Socket

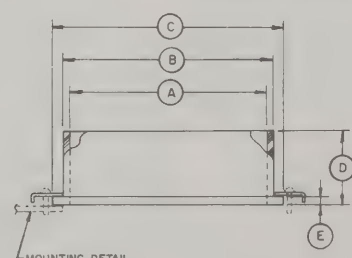
DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN	MAX	REF.	MIN	MAX	REF
A	3 373	3413	- -	8567	86 70	- -
B	2 953	2983	-	7501	7577	- -
C	0 474	0553	- -	1204	1405	- -
D	- -	0 630	- -	- -	600	- -
E	-	- -	0 063	- -	- -	1 60
F	0 140	0 149	-	356	378	-

NOTES:
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. CONNECTIONS.
   - 1-HEATER
   - 2-CATHODE
   - 3-CATHODE
   - 4-CATHODE
   - 5-HEATER
   - 6-CATHODE
   - 7-CATHODE
3. GRID CONTACTS GROUNDED TO MOUNTING PLATE.



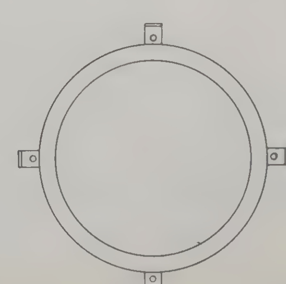
CHASSIS CUT OUT
FOR MOUNTING & REQUIRED COOLING AIR FLOW.





SK-2216 Chimney

TOE CLAMP DETAIL
(4) SUPPLIED
P/N 889901



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN.	MAX.	REF
A	3 385	3 415	-	8598	86 74	- -
B	3 532	3 592	- -	89.71	91.24	- -
C	3 907	3 967	- -	99.24	100.76	- -
D	1 220	1 280	- -	3099	3251	- -
E	0 110	0 140	- -	279	3.56	- -
F	0 417	0 457	- -	10.59	11.61	- -
G	0 292	0 332	-	742	8.43	- -
H	0 292	0 332	- -	742	8.43	- -
J	0 105	0 145	- -	267	368	- -
K	80°	100°	- -	80°	100°	- -
L	0 142	0 146	- -	361	371	- -

NOTES
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. MATERIALS:
   a. CHIMNEY:
      TEFLON TFE
   b. TOE CLAMP
      BRASS-SILVER PLATED

DIVISION OF VARIAN
301 Industrial Way
San Carlos, California

TABLE OF CONTENTS

(Revised 3/15/76)

Printed in U.S.A.

TABLE OF CONTENTS

GENERAL

DIODES-RECTIFIERS

PLANAR TRIODES

TRIODES

TRIODES

2000T	10-15-50
5867A	11-15-64
6696A	10-15-64
6697A	10-15-64
7480	11-1-68
8873/8874/8875	6-3-73
8938	5-15-73

TETRODES

4-65A/8165	5-1-62
4-125A/4D21	6-1-67
4-250A/5D22	5-5-70
4-400A/8438	7-20-70
4-400C/6775	4-1-71
4-500A	3-10-72
4-1000A/8166	10-30-66
4CN15A	6-1-68
4CPX250K/8590	4-1-70
4CS250R	9-1-70
4CV8000A	3-15-71
4CV20,000A	6-1-68
4CV35,000A	5-15-66
4CV50,000E	5-1-70
4CV50,000J	7-15-71
4CV100,000C/8351	2-1-68
4CV250,000A	3-1-72
4CW800B/F	11-1-73
4CW2000A/8244	6-15-71
4CW10,000A/8661	4-15-63
4CW25,000A	2-1-72
4CW50,000E	9-1-75
4CW50,000J	7-15-71
4CW100,000D	9-1-75
4CW100,000E	9-1-70
4CW250,000A	3-1-71
4CX125C/F	6-1-67
4CX250B/7203 & 4CX250FG/8621	8-1-74
4CX250BC/8957	1-1-74
4CX250K/8245 & 4CX250M/8246	5-1-68
4CX250R/7580W	6-16-61
4CX300A/8167	8-30-66
4CX300Y/8561	6-15-66
4CX350A/8321 & 4CX350F/8322	6-15-65
4CX350FJ/8904	9-1-71
4CX600B & 4CX600F	3-20-70
4CX600J/8809 & 4CX600JA/8921	8-15-71
4CX1000A/8168	5-1-70
4CX1000K/8352	8-20-66
4CX1500A	12-1-71
4CX1500B/8660	6-1-67
4CX3000A/8169	1-20-76
4CX5000A/8170	4-15-69
4CX5000J/8909	10-1-71
4CX5000R/8170W	4-15-71
4CX10,000D/8171	1-1-72
4CX10,000J	2-1-72
4CX15,000A/8281	12-15-73
4CX15,000J/8910	10-15-71
4CX35,000C/8349	9-1-75
4W300B/8249	11-1-73
4X150A/7034 & 7609	8-1-74
4X150G/8172	10-15-73
4X500A	1-1-64
6816,6884,7843	11-15-71
7609	see 4X150A/7034
8560A	7-15-71
8876	6-15-71
8930	12-1-73
8954	6-1-74
8959	11-1-74
X2159	7-1-73

PENTODES

5-125B/4E27A	8-15-52
5-500A	5-1-68
5CX1500A	11-15-75
5CX3000A	8-1-67
264/8576	6-5-70
290	5-5-70
8295A	1-15-73

PULSE MODULATORS

4PR60C/8252W	6-30-71
4PR65A/8187	2-15-63
4PR125A/8247	3-15-64
4PR250C/8248	9-1-70
4PR400A/8188	9-15-65
4PR1000A/8189	12-15-65
6C21	12-15-65

OTHER PRODUCTS

VS-2, 4 & 6	9-1-75
Preformed Contact Finger Stock	6-15-71
HR Heat Dissipating Connectors	12-1-65
SK-300A	4-15-69
SK-306, SK-316	8-15-66
SK-400	4-1-56
SK-406, SK-416, SK-426	12-1-73
SK-410	12-1-73
SK-500	3-15-67
SK-506, SK-516	4-15-69
SK-510	3-15-75
SK-600A, SK-610A	11-1-74
SK-606, SK-626, SK-636B, SK-646	11-1-74
SK-607	8-15-71

(Cont'd)

OTHER PRODUCTS

SK-620, SK-620A	7-1-75
SK-630, SK-630A	7-1-75
SK-640	7-1-75
SK-650, SK-655	1-15-66
SK-700, SK-710	10-15-66
SK-711A, SK-712A	3-15-71
SK-740	7-15-75
SK-760, SK-770	7-15-75
SK-800B, SK-806	4-9-64
SK-810B, SK-806	6-1-67
SK-816, SK-860, SK-870	3-25-75
SK-890B, SK-806	6-1-67
SK-900, SK-906	8-15-66
SK-1300, SK-1310, SK-1320	3-1-72
SK-1306, SK-1406	8-15-66
SK-1400A, SK-1470A	10-15-66
SK-2200, SK-2210	8-15-72

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2-1-76

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TECHNICAL DATA

8940

PLANAR TRIODE

The 8940 is a planar triode of ceramic/metal construction and rugged design to be used in advanced airborne, ground, and space applications up to 2.5 GHz.

The 8940 may be used as an amplifier, oscillator, or frequency multiplier in the CW as well as the grid or plate-pulsed mode, or as a modulator or series regulator tube. In addition to the low interelectrode capacitance, high transconductance and amplification factor, the tube has an arc-resistant cathode and a vaporization shield to assure stable and reliable long life operation under adverse conditions.

The 8940 is normally supplied without a radiator and may be conduction, convection, heat-sink, or liquid cooled. Liquid cooling can be done by submersion of the tube in an insulating medium such as FC-75. Radiators for forced-air cooling as well as heat-sink adaptors permitting anode dissipation up to 750 watts are available as separate items.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	2.25	A
Transconductance (Average):		
I_b = 160 mA	100	mmhos
Amplification Factor (Average):	65	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	16.0	pF
Cout	0.11	pF
Cgp	3.8	pF
Cut-off Bias[3]	-50	V max
Frequency of Maximum Rating:		
Plate or Grid-Pulsed	2.5	GHz
CW	2.0	GHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 2 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 10-15-75) Printed in U.S.A.

EIMAC division of varian / 301 industrial way / san carlos / california 94070

MECHANICAL

Maximum Overall Dimensions:	
Length	1.985 in; 50.4 mm
Diameter	1.365 in; 34.6 mm
Net Weight	1.96 oz; 56 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Conduction, convection, forced air, or liquid

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	2.05	2.50	A
Cathode Warmup Time	90	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	13.5	17.0	pF
Cout	---	0.11	pF
Cgp	3.3	4.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE(grid pulsed)	4000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	6500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	500	VOLTS
Grid positive to cathode	200	VOLTS
PULSE PLATE CURRENT	12	AMPERES
PULSE GRID CURRENT	4	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	2.5	GHz
PULSE DURATION[2]	6	μs
DUTY FACTOR[2]	.0033	

OPERATING CONDITIONS for 8940 in Respresentative Application

	Grid Pulsed Amplifier		Grid Pulsed OSC	Plate Pulsed OSC	
Frequency	1.3	1.2	1.03	1.65	GHz
Heater Voltage	6.3	6.3	6.3	6.3	V
DC Plate Voltage	4000	3500	3850	5000	Vdc
DC Grid Voltage	-50	-75	-80	--	Vdc
Peak Video Plate Current	3.0	3.0	6.0	6.0	a
Peak Video Grid Current	0.7	0.5	1.8	2.0	a
Pulse Drive Power(approx.)	600	600	--	--	w
Useful Power Output(")	6000	4000	11,500	10,000	w
Pulse Duration	500	3.5	5.0	5.0	μs
Duty Factor	0.01	0.04	.001	.001	
Bandwidth	75	10	--	--	MHz

1. Using EIMAC Radiator Part No. 158096.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
PEAK PLATE VOLTAGE	6500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	500	VOLTS
Grid positive to cathode	100	VOLTS
PULSE CATHODE CURRENT	16	AMPERES
DC PLATE CURRENT	600	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2.0	WATTS
PULSE DURATION[2]	6	μs
CUT-OFF MU	35	

1. Using EIMAC Radiator Part No. 158096.

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC GRID VOLTAGE	-200	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	350	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	0.6	AMPERE
DC GRID CURRENT	0.07	AMPERE
AVERAGE PLATE DISSIPATION		
Forced-Air Cooling [1]	750	WATTS
GRID DISSIPATION (Average)	2.0	WATTS

1. Using EIMAC Radiator Part No. 158096.

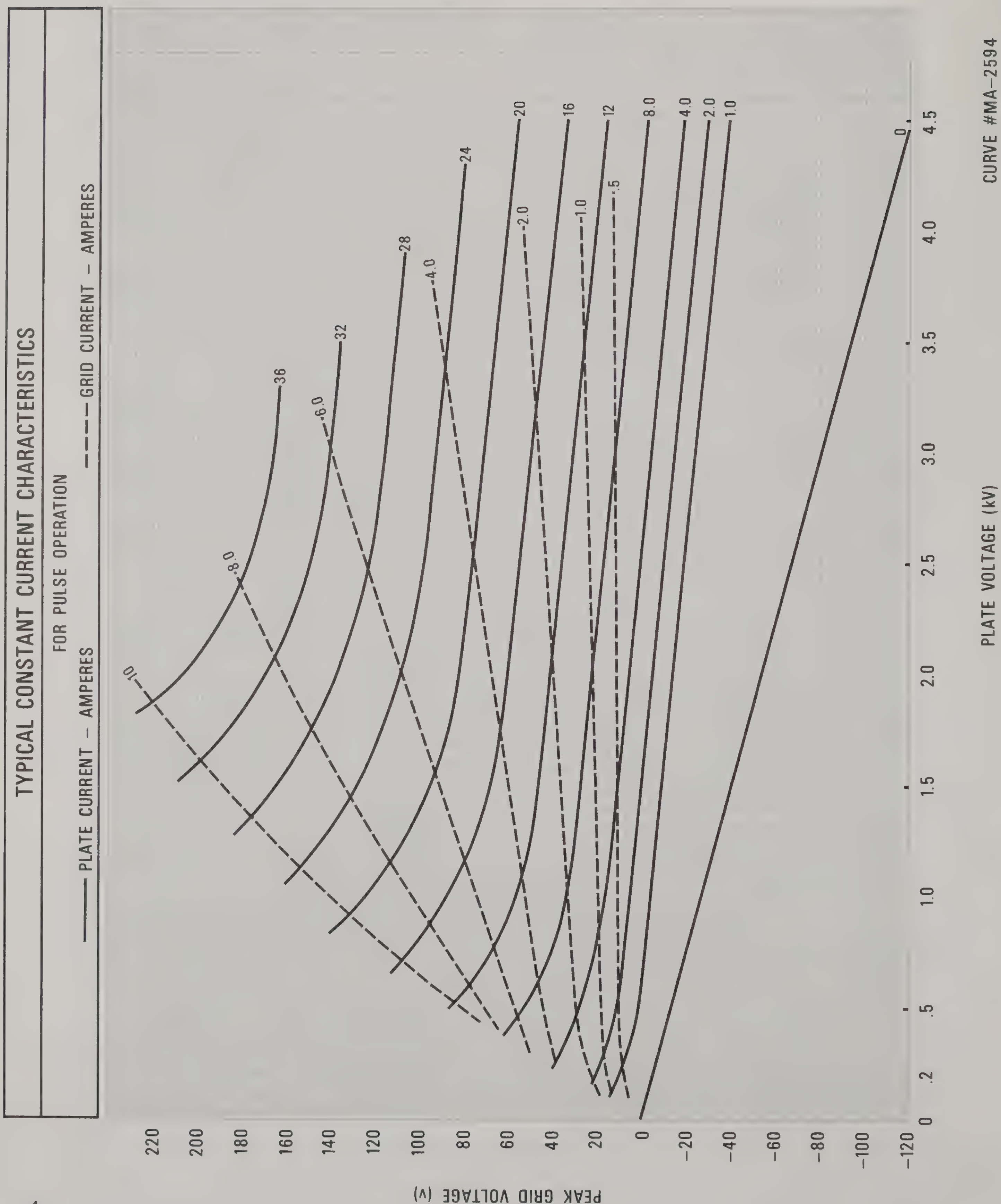
APPLICATION

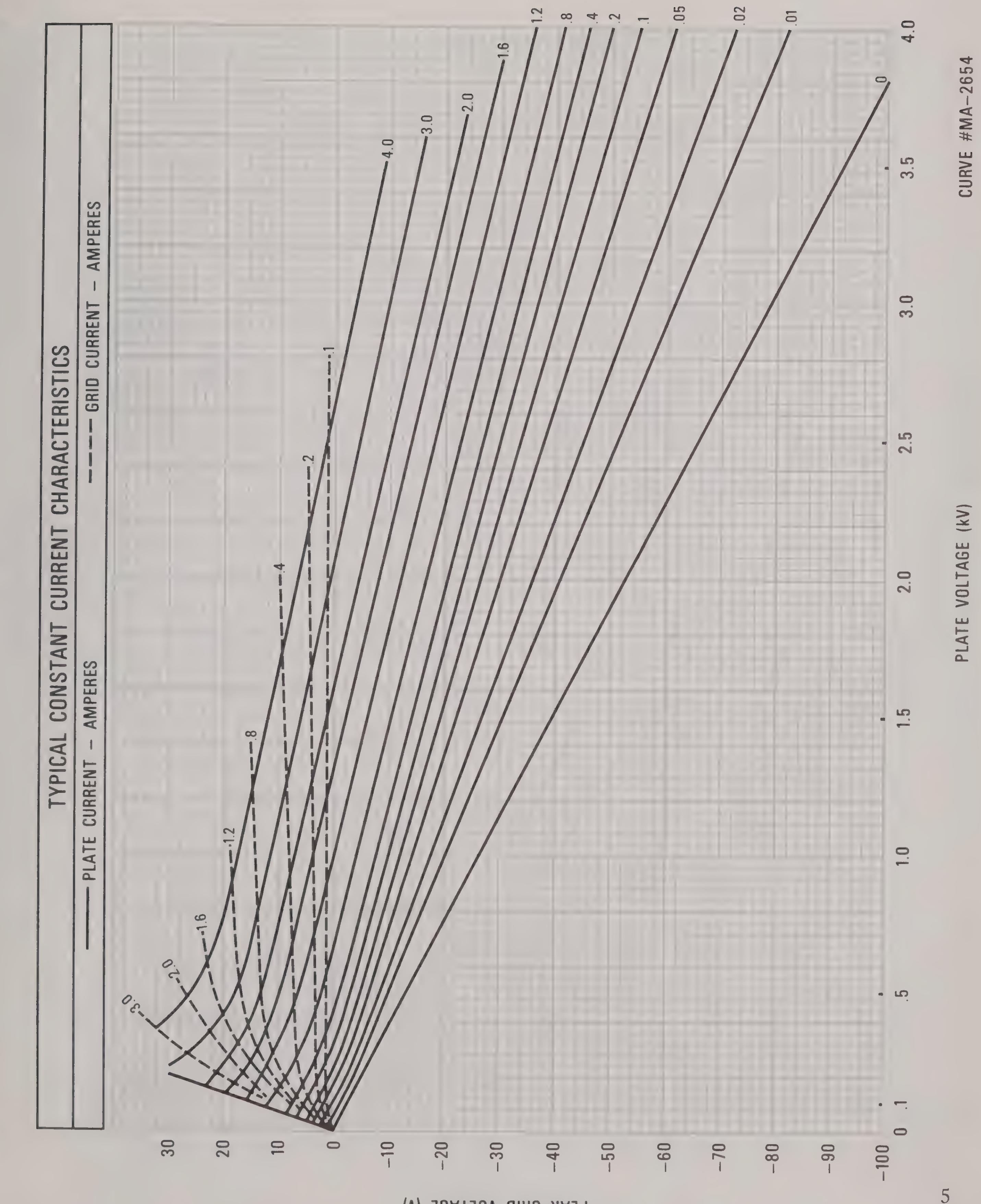
For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

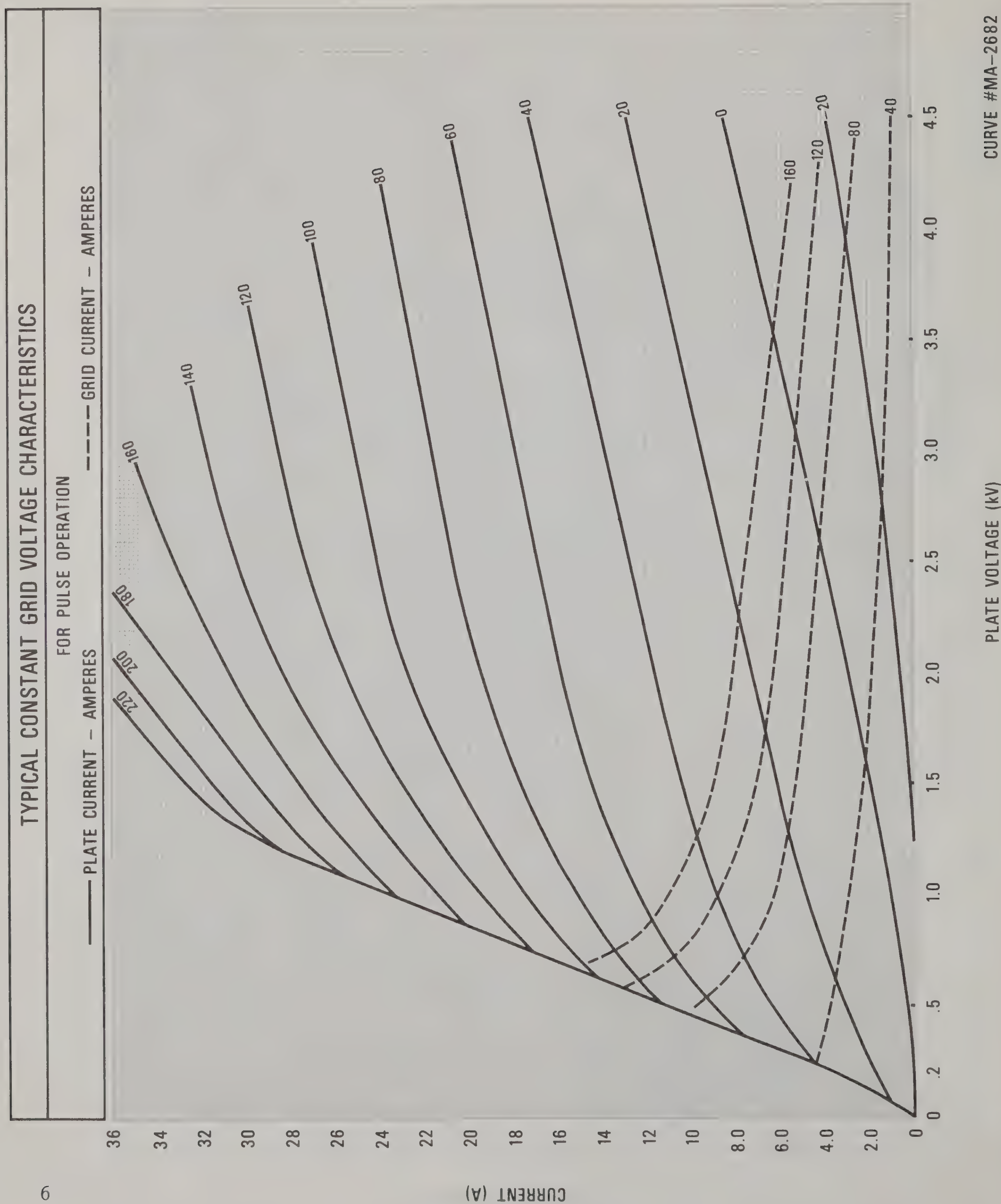
The cathode and grid flanges should not be altered in any way such as by machining or filing, since the final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.

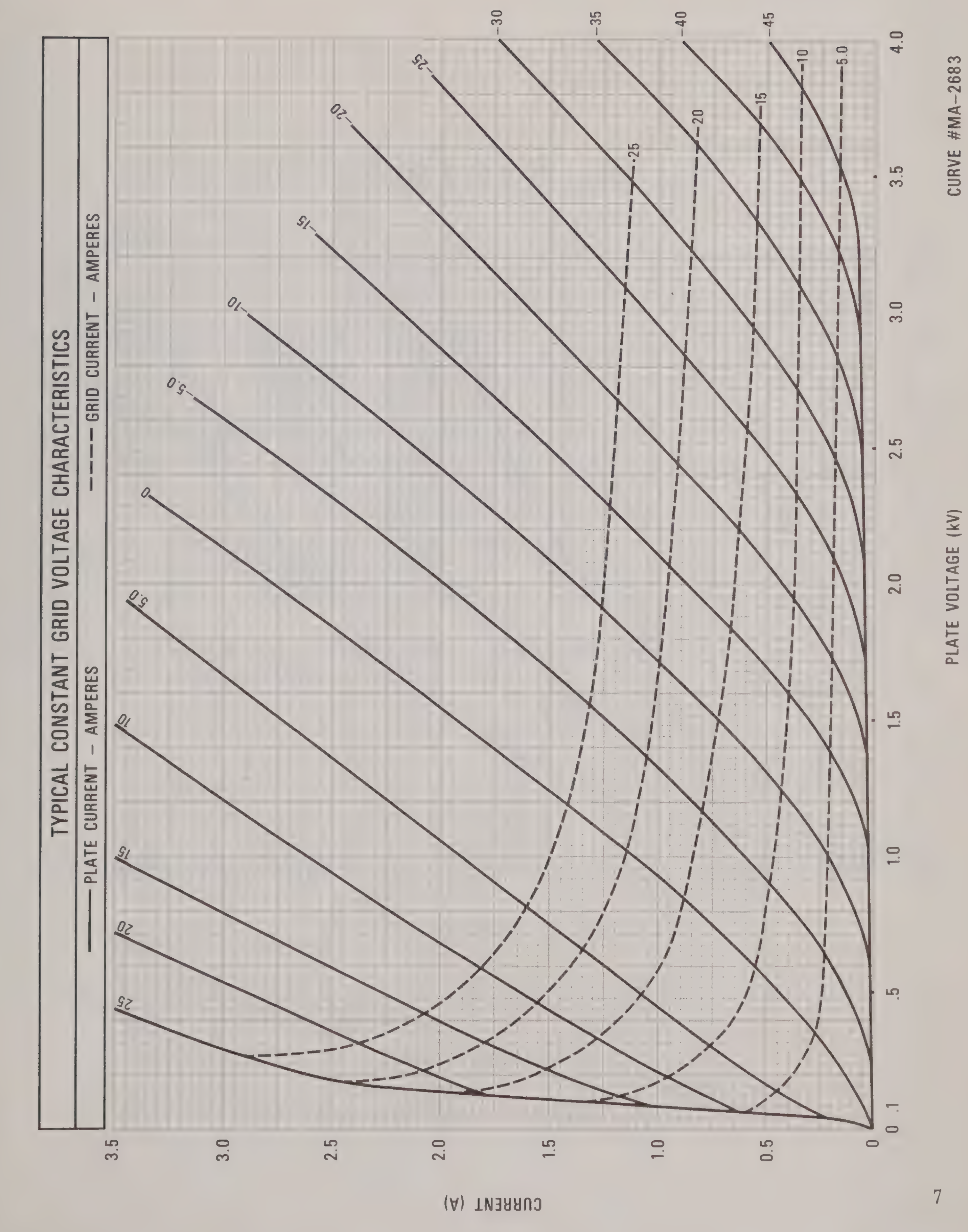
For optimum RF performance, the anode line should make good contact on the anode area indicated on the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas. If forced air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
FOR PULSE OPERATION
—— PLATE CURRENT – AMPERES
– – – – GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #MA-2594

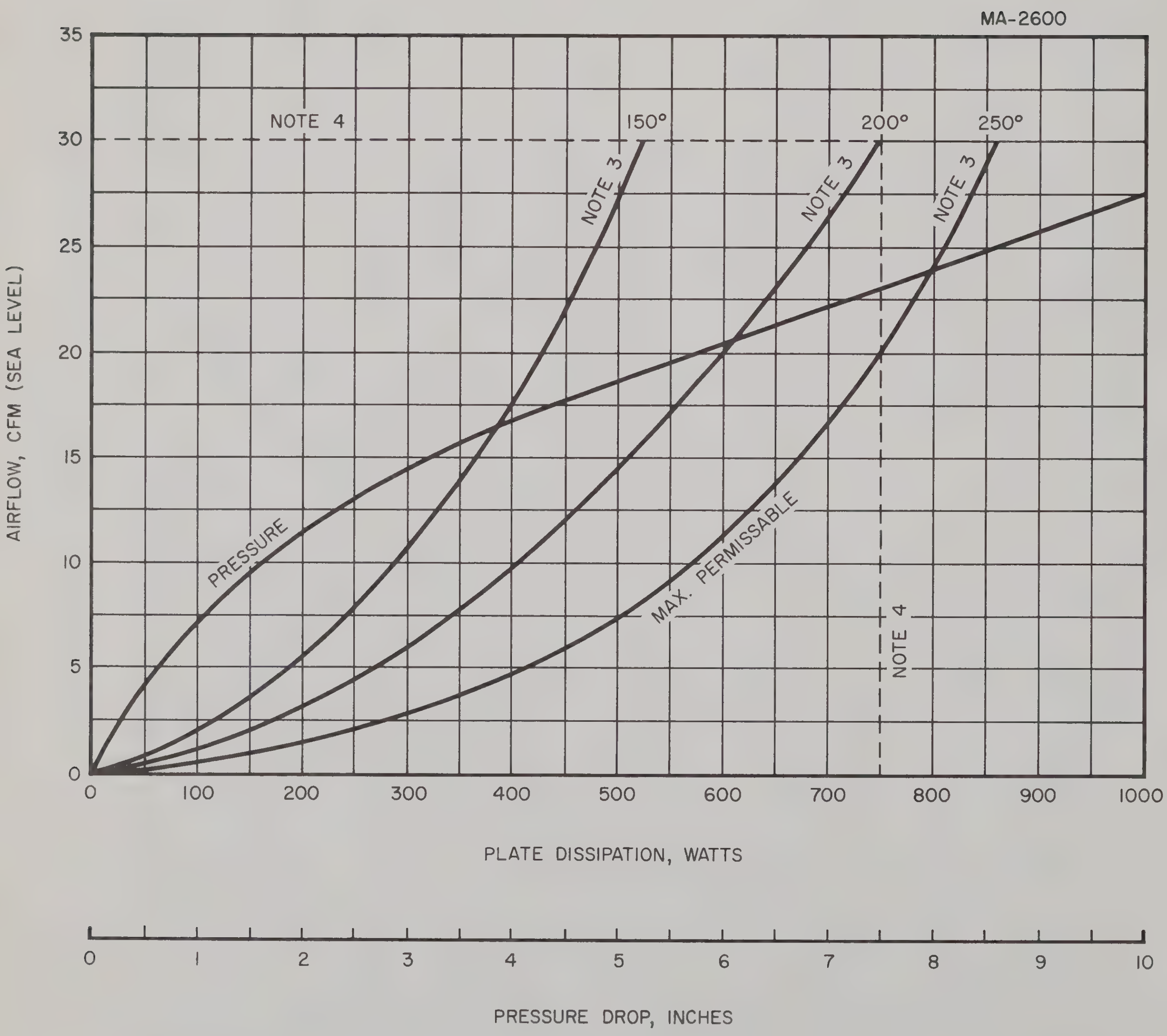

TYPICAL CONSTANT CURRENT CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #MA-2654

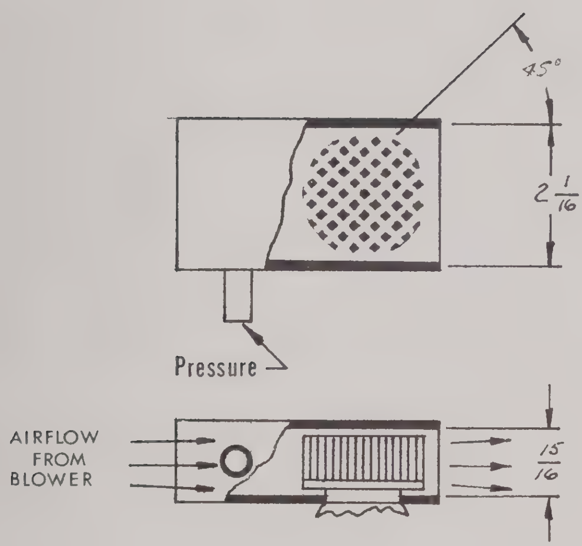

TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS
FOR PULSE OPERATION
——— PLATE CURRENT – AMPERES
– – – – GRID CURRENT – AMPERES
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
160
120
80
40
CURRENT (A)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8.0
6.0
4.0
2.0
0
0
.2
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
PLATE VOLTAGE (kV)
CURVE #MA-2682



TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS
—— PLATE CURRENT - AMPERES
- - - - GRID CURRENT - AMPERES
CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA-2683
0
.1
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0.5
25
20
15
10
5.0
0
-5.0
-10
-15
-20
-25
-30
-35
-40
-45

AIR COOLING DATA FOR 8940





– COWLING DETAIL –

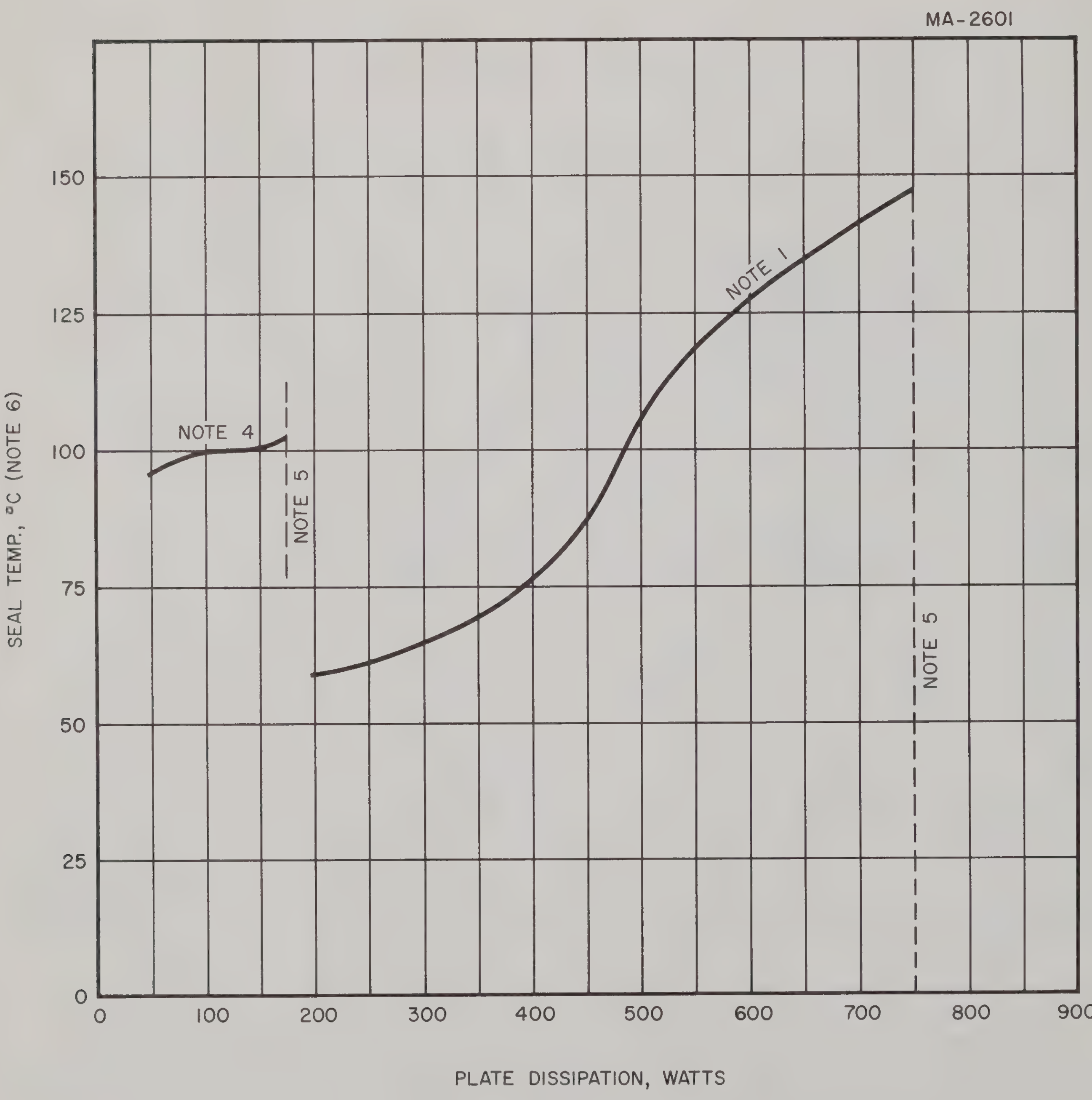
1. Inlet Air at 20°C

2. Use Radiator No. 158096 (Copper–Pin) in Cowling as shown.

3. Temp. measured at Anode Cup–Plate Insulator Seal.

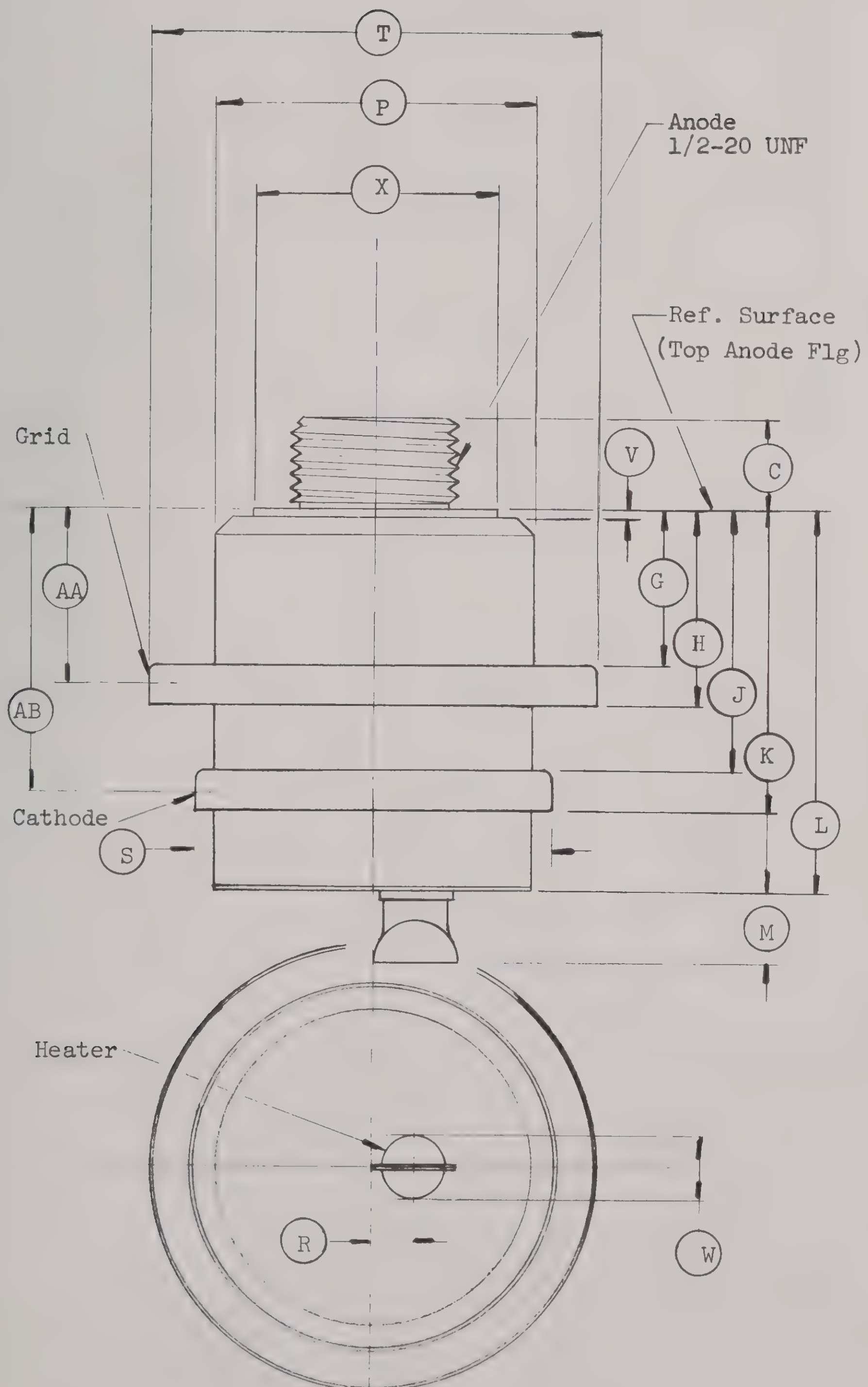
4. Describes Typical MAX. CW Operating Point.

COOLING DATA FOR 8940 IN FC 75 DIELECTRIC COOLANT



NOTES:

1. USE RADIATOR 158096 (Copper - Pin)
2. TUBE AXIS VERTICAL IN LIQUID.
3. LIQUID AMBIENT TEMPERATURE 40°C.
4. TUBE W/O COOLER STUD COOLING ONLY.
5. MAX. CW RATING - CONTACT PLANAR MGR. EIMAC, SLC ON INTERMEDIATE OR HIGHER POWERS THAN SHOWN.
6. SEAL TEMPERATURE IS MEASURED AT PLATE TO ANODE INSULATOR FLANGE (SEE 'V' ON OUTLINE DWG.)



DIM	INCHES MIN.	INCHES MAX	INCHES REF.	MILLIMETERS MIN	MILLIMETERS MAX	MILLIMETERS REF.
C	0.500	0.600	- -	12.70	15.24	- -
G	0.385	0.410	- -	9.78	10.41	- -
H	0.510	0.545	- -	12.95	13.84	- -
J	0.655	0.710	- -	16.64	18.03	- -
K	- -	0.845	- -	- -	21.46	- -
L	0.930	1.010	- -	23.62	25.65	- -
M	0.300	0.375	- -	7.62	9.52	- -
P	0.940	0.965	- -	23.88	24.51	- -
R	0.090	0.110	- -	2.29	2.79	- -
S	1.065	1.085	- -	27.05	27.56	- -
T	1.345	1.365	- -	34.19	34.67	- -
V	- -	0.035	- -	- -	0.89	- -
W	- -	- -	0.190	- -	- -	4.83
X	0.740	0.770	- -	18.80	19.56	- -
AA	(see note 2,3)		0.460	- -	- -	11.68
AB	(see note 2,3)		0.750	- -	- -	19.05

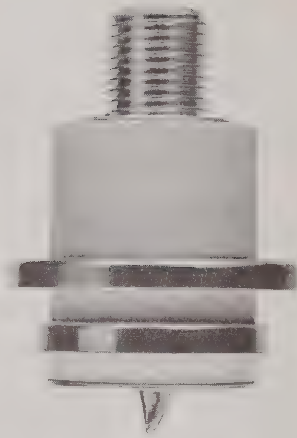
NOTES:

1. Ref. Dims. are for info. only & are not req'd for inspection purposes.
2. Contact Surface dims. AA & AB are for cavity design purposes only & are not intended as inspection criteria
3. Contact surfaces are ± .030 around dim. indicated.
4. TIR of Contact Surfaces are specified in individual Tube Electrical Specs.

8941/Y690

TECHNICAL DATA

PLANAR TRIODE



The 8941 is a planar triode of ceramic/metal construction designed for use in airborne, ground and space applications as a grid or plate pulsed oscillator, amplifier, or frequency multiplier at frequencies up to 2.0 GHz. The extended grid to cathode insulator permits reliable operation in some applications to 12 KV[1]. The other special features of this tube include high transconductance, high mu and high current capability from an arc-resistant, extended interface matrix cathode.

The tube is normally supplied without radiator and may be conduction, convection, heat sink or liquid cooled such as immersion in an insulating medium (eg. FC-75). Radiators for forced-air cooling as well as heat sink adapters permitting anode dissipations up to 750 watts are available as separate items.

The Y-690 is an 8941 which has been specially processed for series regulator and switch tube service and will operate in some applications to 15 KV[1]. Solder tabs are available on special request permitting attachment of flying leads for grid, cathode and heater connections.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	2.25	A
Transconductance (Average):		
I_b = 160 mA	75	mmhos
Amplification Factor (Average):	200	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	14.0	pF
Cout	0.11	pF
Cgp	2.5	pF
Cut-off Bias[3]	-20	V max.
Frequency of Maximum Rating:		
CW	2000	MHz
Plate or Grid-Pulsed	2000	MHz

1. Characteristics and operating values are based upon performance tests and environmental conditions. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 2 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 10-15-75) Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.235 in; 56.77 mm
Diameter	1.365 in; 34.60 mm
Net Weight	1.96 oz; 56 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Conduction, convection, liquid or forced air

ENVIRONMENTAL

Shock: 11 ms, non-operating	60 G
Vibration: Operating, All Axis	10 G
Altitude; max., in suitably designed circuit	60,000 ft.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	2.05	2.50	A
Cathode Warmup Time	90	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	12.5	16.5	pF
Cout	---	0.11	pF
Cgp	2.0	3.0	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 2 pF due to thermal expansion of the cathode.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (grid pulsed)	10,000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	12,000	VOLTS
DC GRID VOLTAGE	-350	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	175	VOLTS
PULSE PLATE CURRENT	12	AMPERES
PULSE GRID CURRENT	3.0	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2.0	WATTS
FREQUENCY	2.0	GHz
PULSE DURATION[2]	6.0	μs
DUTY FACTOR[2]	.0033	

1. Using EIMAC radiator PN 158096.

Operating Conditions for 8941 in representative applications:

	Cathode Biased, rf Pulsed Amplifier[3]	Grid Pulsed Amplifier	
Frequency	1850	1090	MHz
Heater Voltage	6.3	6.3	V
DC Plate Voltage	4500	5000	Vdc
DC Grid Voltage	-40	-60	Vdc
Peak Video Plate Current	3.1	4.0	a
Peak Video Grid Current	.6	.75	a
Useful Power Output	4.2	10.0	kw (peak)
Pulse Duration	3.0	3.0	μs
Duty Cycle	0.04	0.001	
Gain	11.5	12.0	dB
Bandwidth	20	---	MHz

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

3. No gate pulse used.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE (Type Y-690)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
PEAK PLATE VOLTAGE	18,000	VOLTS
DC GRID VOLTAGE	-350	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	100	VOLTS
PULSE CATHODE CURRENT	16	AMPERES
DC PLATE CURRENT	600	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling 1	750	WATTS
GRID DISSIPATION (Average)	2	WATTS
PULSE DURATION 2	6.0	μs
DUTY FACTOR 2	.0033	
CUT-OFF MU	90	

1. Using EIMAC radiator PN 158096.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

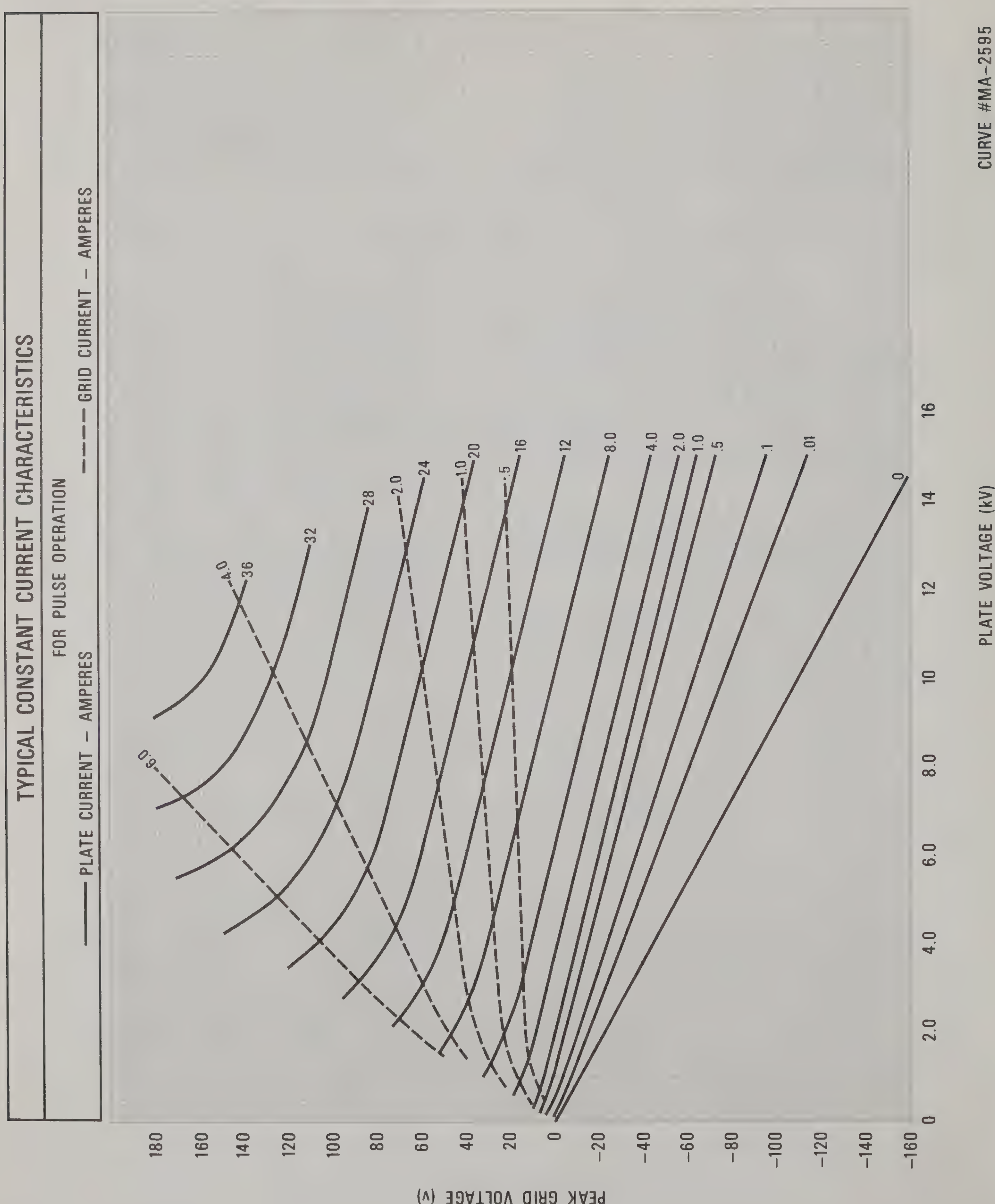
APPLICATION

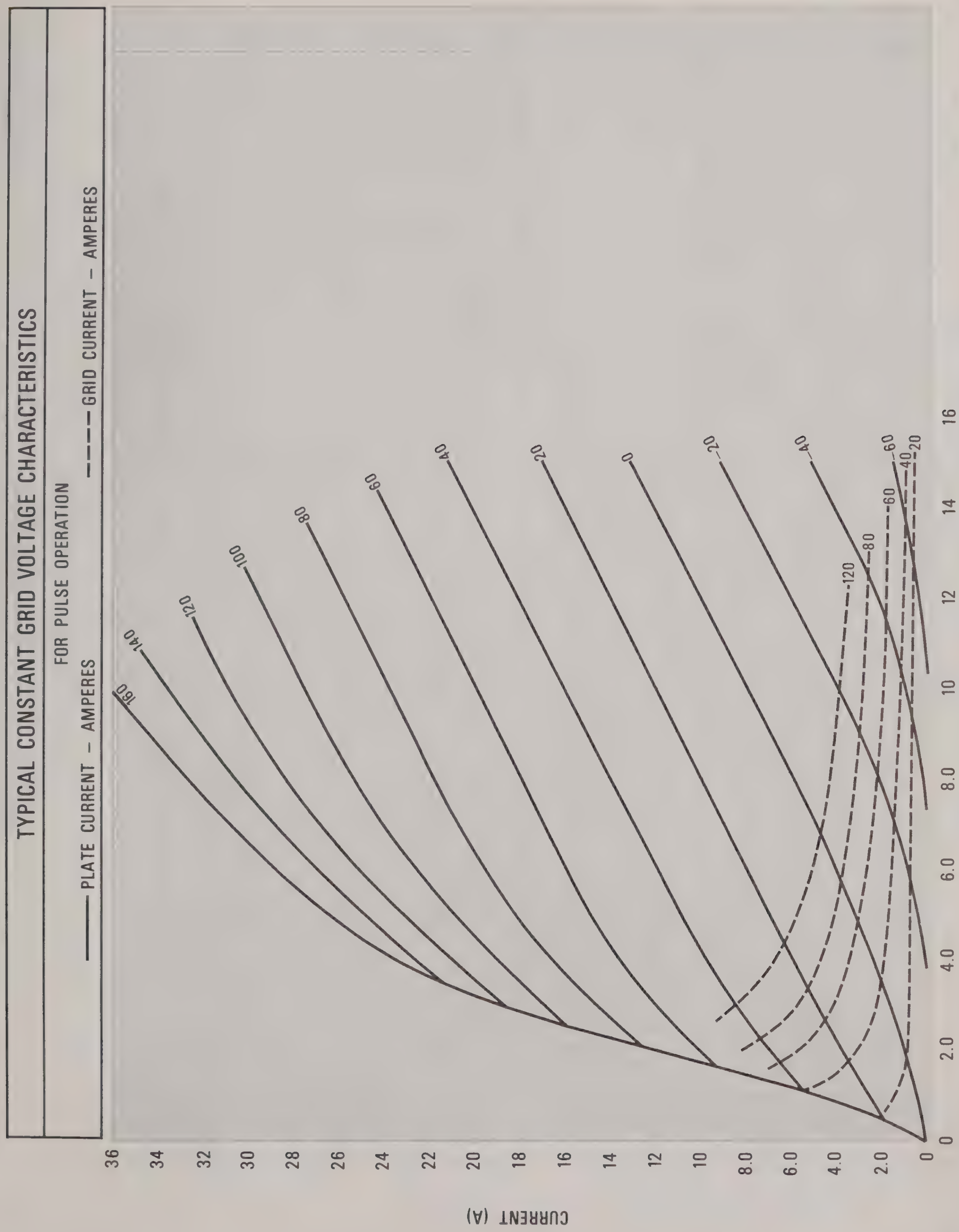
For general application information please refer to the Planar Triode Operazing Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

The cathode and grid flanges should not be altered in any way such as be machining or filing, since the final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.

For optimum RF performance, the anode line should make good contact on the anode area indicated on the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas. If forced air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C.

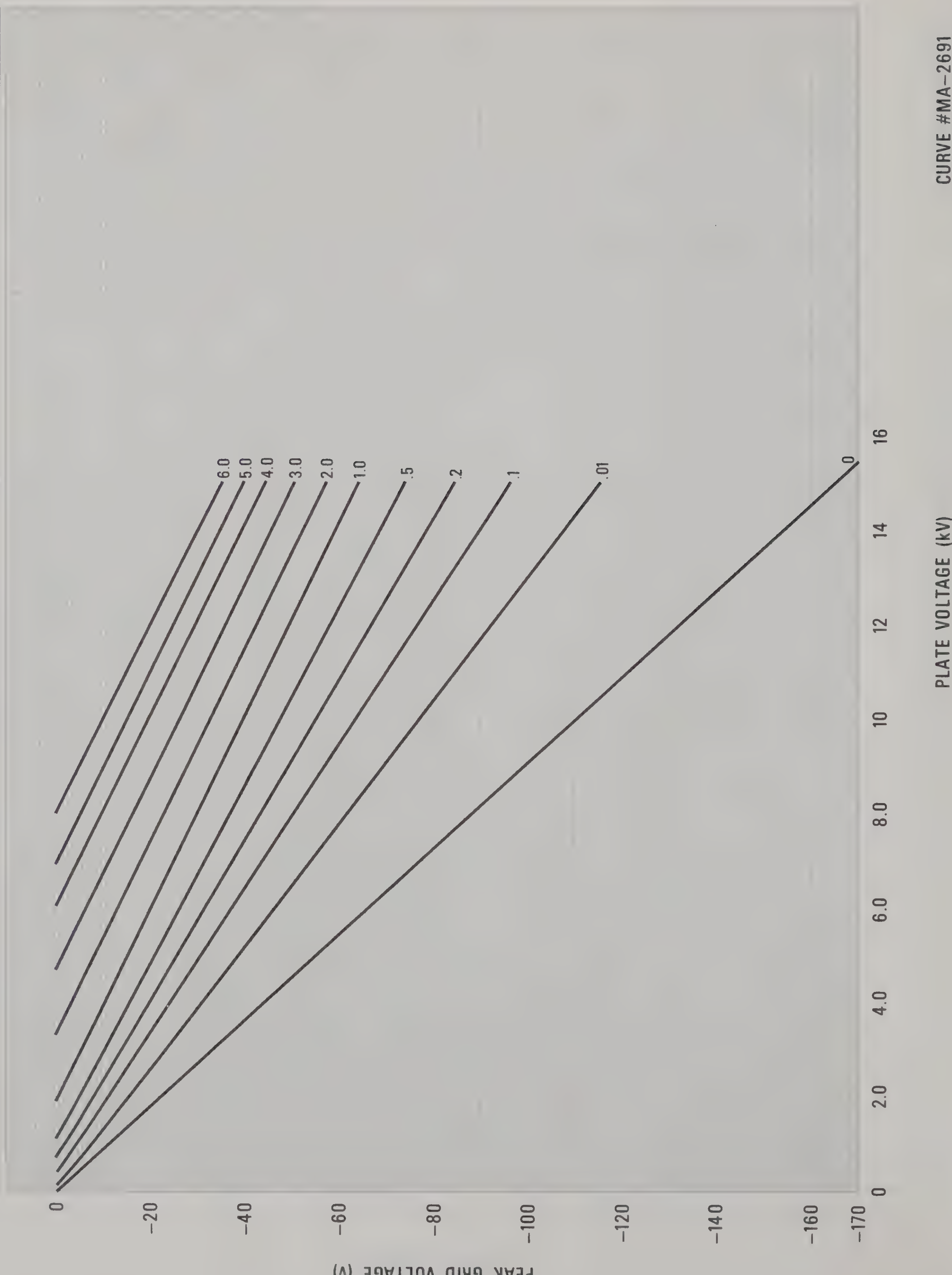

TYPICAL CONSTANT CURRENT CHARACTERISTICS
FOR PULSE OPERATION
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (v)
180
160
140
120
100
80
60
40
20
0
–20
–40
–60
–80
–100
–120
–140
–160
PLATE VOLTAGE (kV)
0
2.0
4.0
6.0
8.0
10
12
14
16
36
32
28
24
20
16
12
8.0
4.0
2.0
1.0
.5
.1
.01
0
6.0
4.0
2.0
1.0
.5
CURVE #MA-2595



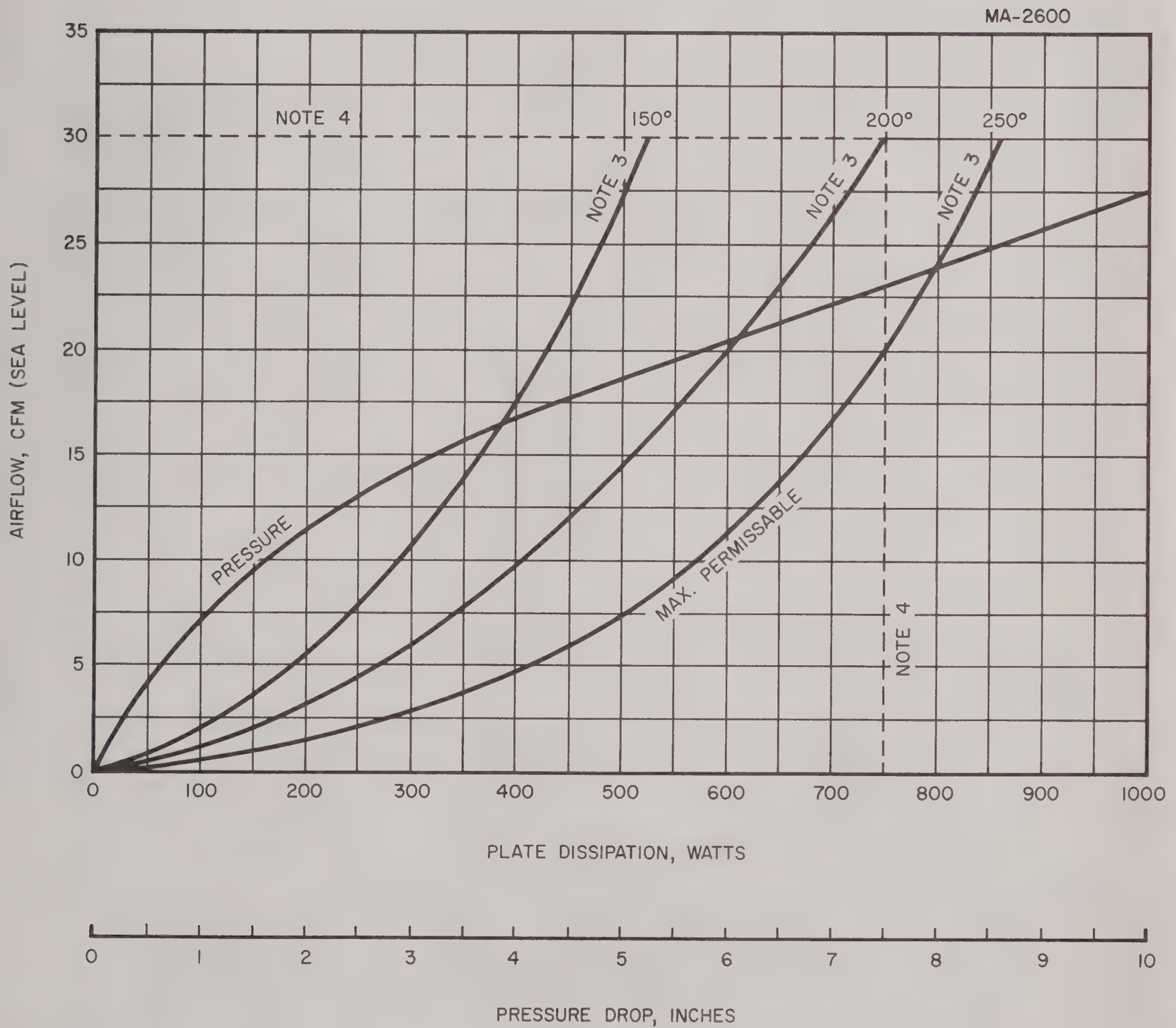
CURVE #MA-2692

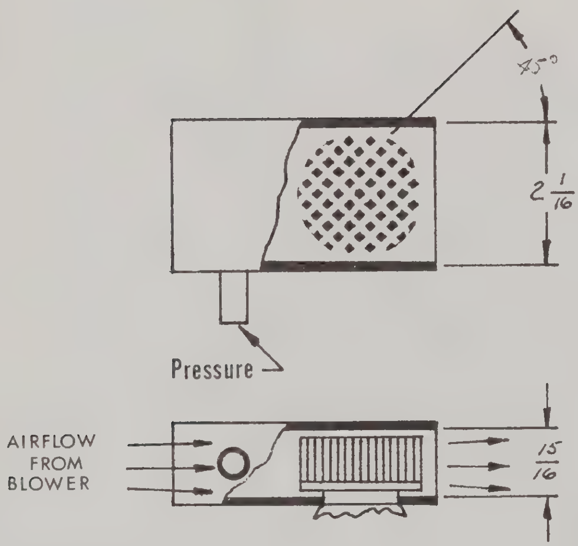
TYPICAL CONSTANT PLATE CURRENT CHARACTERISTICS

NEGATIVE GRID VOLTAGE REGION



AIR COOLING DATA FOR 8941





— COWLING DETAIL —

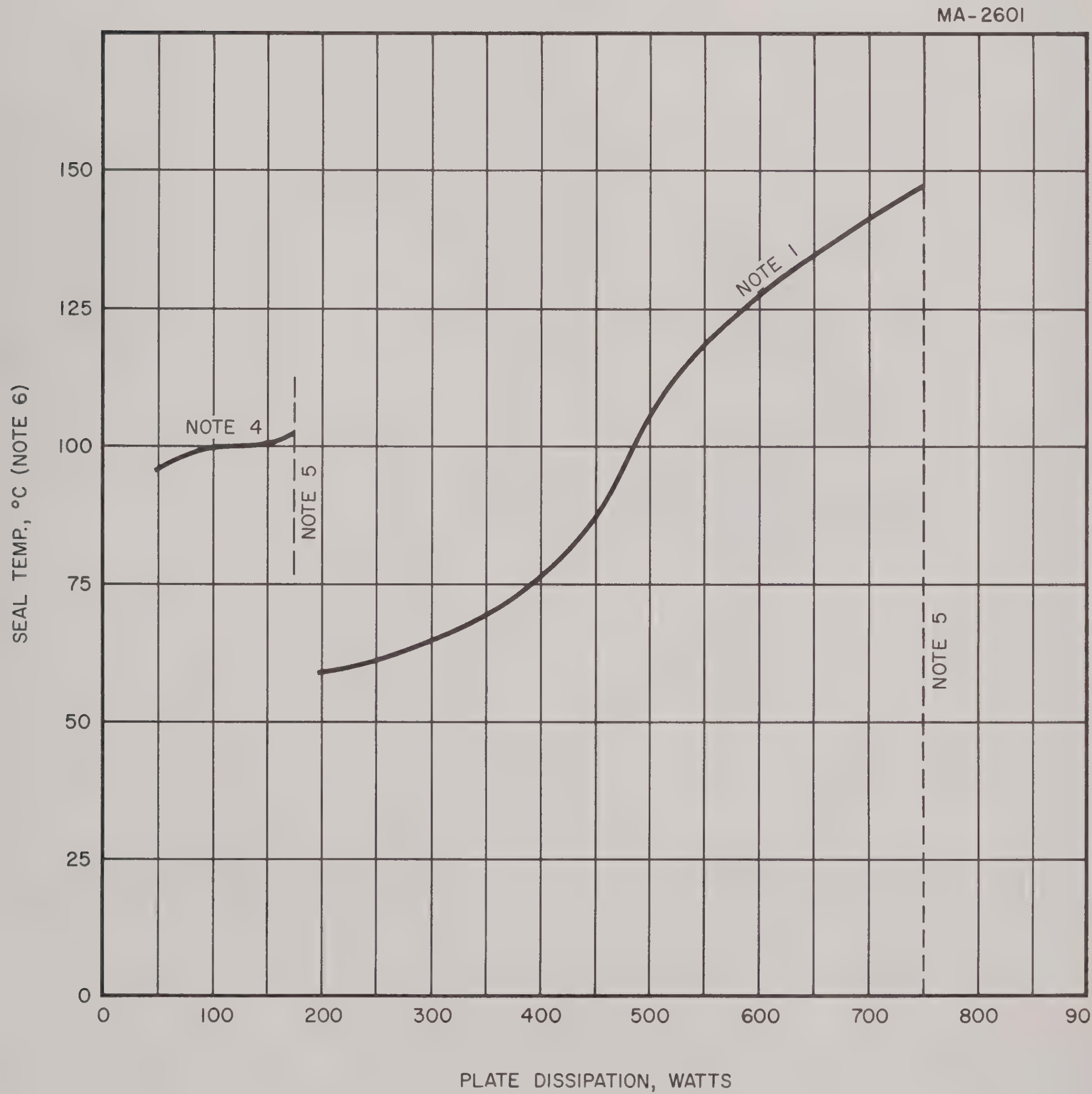
1. Inlet Air at 20°C

2. Use Radiator No. 158096 (Copper–Pin) in Cowling as shown.

3. Temp. measured at Anode Cup–Plate Insulator Seal.

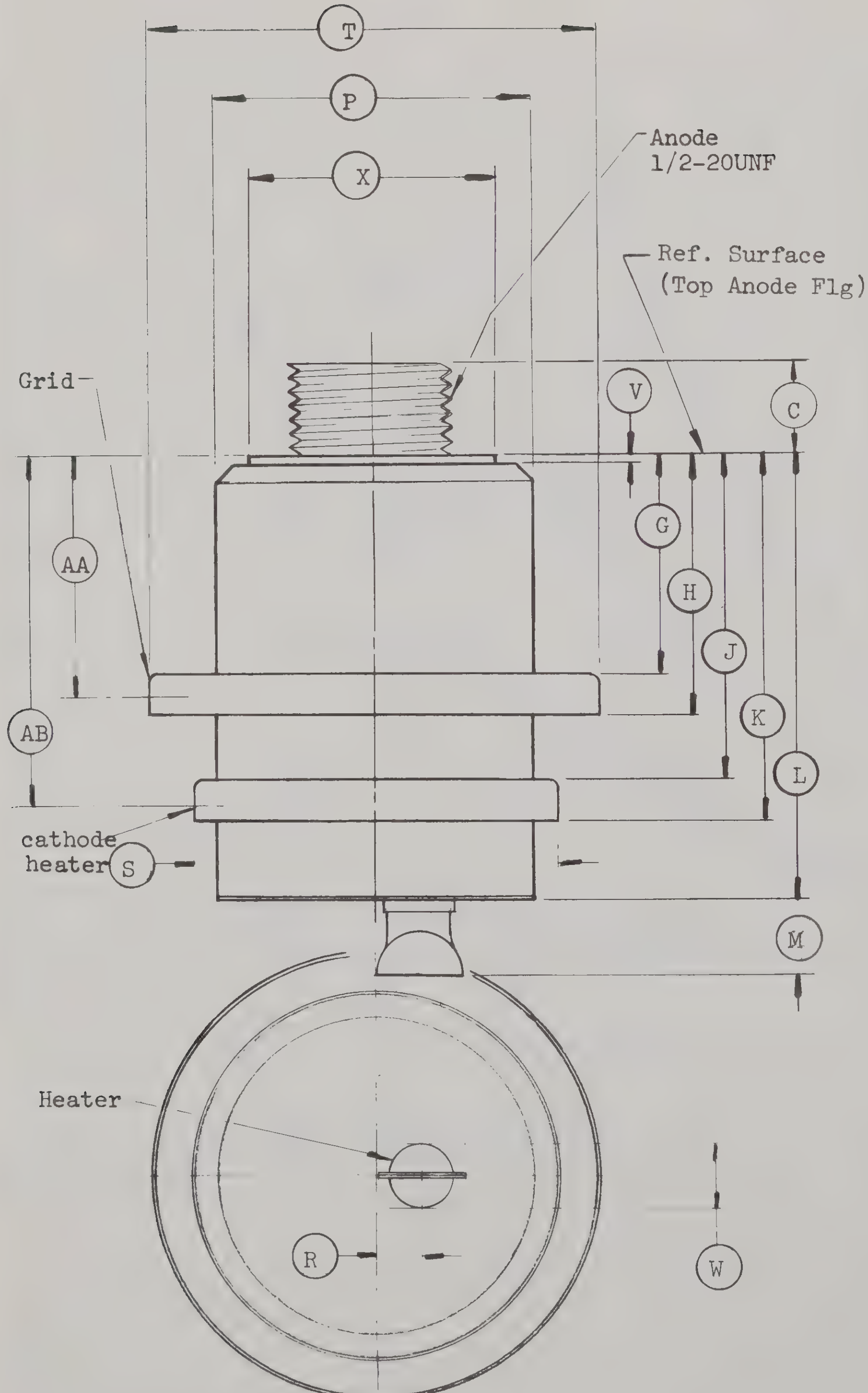
4. Describes Typical MAX. CW Operating Point.

COOLING DATA FOR 8941 IN FC 75 DIELECTRIC COOLANT



NOTES:

1. USE RADIATOR 158096 (Copper - Pin)
2. TUBE AXIS VERTICAL IN LIQUID.
3. LIQUID AMBIENT TEMPERATURE 40°C.
4. TUBE W/O COOLER STUD COOLING ONLY.
5. MAX. CW RATING - CONTACT PLANAR MGR. EIMAC, SLC ON INTERMEDIATE OR HIGHER POWERS THAN SHOWN.
6. SEAL TEMPERATURE IS MEASURED AT PLATE TO ANODE INSULATOR FLANGE (SEE 'V' ON OUTLINE DWG.)



DIM	INCHES MIN.	INCHES MAX.	INCHES REF.	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF.
C	0.500	0.600	- -	12.70	15.24	- -
G	0.635	0.660	- -	16.13	16.76	- -
H	0.760	0.795	- -	19.30	20.19	- -
J	0.905	0.960	- -	22.99	24.38	- -
K	- -	1.095	- -	- -	27.81	- -
L	1.180	1.260	- -	29.97	32.00	- -
M	0.300	0.375	- -	7.62	9.52	- -
P	0.940	0.965	- -	23.88	24.51	- -
R	0.090	0.110	- -	2.29	2.79	- -
S	1.065	1.085	- -	27.05	27.56	- -
T	1.345	1.365	- -	34.16	34.67	- -
V	- -	0.035	- -	- -	0.89	- -
W	- -	- -	0.190	- -	- -	4.83
X	0.760	0.815	- -	19.30	20.70	- -
AA	(see note 2,3)		0.710	- -	- -	18.03
AB	(see note 2,3)		1.000	- -	- -	25.40

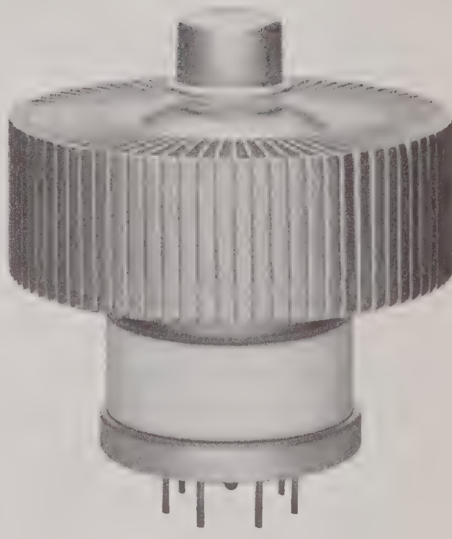
NOTES:

1. Ref. Dims .are for info only & are not req'd for inspection purposes.
2. Contact Surface Dims. AA & AB are for cavity design purposes only & are not intended as inspection criteria
3. Contact Surfaces are ± .030 around dim. indicated.
4. TIR of Contact Surfaces are specified in individual Tube Electrical Specs.

TECHNICAL DATA

3CPX1500A7

HIGH-MU
POWER TRIODE



The EIMAC 3CPX1500A7 is a rugged ceramic/metal high-mu power triode, designed with beam-forming cathode and control-grid geometry to allow the simplicity of design and circuit advantages of a triode with the gain of a tetrode.

The 3CPX1500A7 is intended for pulse modulator or pulse regulator service, with a pulse plate current rating of 50 amperes, and a voltage holdoff rating of 10,000 volts in air, with forced-air cooling of the anode, or 15,000 volts when immersed in a suitable dielectric liquid which is also used for tube cooling.

An Air-System Socket (EIMAC SK-2200) and an Air Chimney (EIMAC SK-2216) are available for those applications requiring forced-air cooling.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: Voltage	5.5 ± 0.25 V
Current, at 5.5 volts	11.2 A
Transconductance (Average, with $I_b = 1.0$ Adc)	55,000 μmhos
Amplification Factor (Average)	200
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	38.5 pF
Cout	0.1 pF
Cgp	10 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:

Length	4.02 in; 102 mm
Diameter	3.38 in; 86 mm
Net Weight	26 oz; 735 gm
Operating Position	Any
Maximum Operating Temperature, Ceramic/Metal Seals or Anode Core	250° C
Cooling	Forced Air or Liquid Immersion

Base	Special 7-Pin
Recommended Air-System Socket	EIMAC SK-2200
Recommended Air Chimney	EIMAC SK-2216

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 5.5 volts	10.2	12.2	A
Cathode Warmup Time	90	---	sec
Interelectrode Capacitance (grounded cathode connection) [1]			
Cin	36.0	41.0	pF
Cout	---	0.2	pF
Cgp	9.2	11.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

PULSE MODULATOR OR SWITCH TUBE SERVICE

ABSOLUTE MAXIMUM RATINGS:

	In Air	In Oil	
HEATER VOLTAGE	5.5±5%	5.5±5%	VOLTS
DC PLATE VOLTAGE	10.0	15.0	KILOVOLTS
DC GRID VOLTAGE	-200	-200	VOLTS
PEAK PLATE CURRENT[1]	50	50	AMPERES
PULSE LENGTH & DUTY [1]	See Derating Chart		
PLATE DISSIPATION[2]	1500	1500	WATTS
GRID DISSIPATION	25	25	WATTS

1. Pulse length, pulse plate current, and duty are interrelated; see Derating Chart.
2. Plate dissipation values shown are nominal; capability is dependent on cooling technique and equipment design. In all cases the ABSOLUTE MAXIMUM temperature ratings should not be exceeded, and for best life and consistent performance operation at lower temperatures is normally beneficial.
3. Approximate value.

TYPICAL OPERATION - Pulse Modulator Service

Plate Voltage	10.0	15.0	kVdc
Pulse Plate Current	40	40	a
Grid Voltage	-125	-150	Vdc
Pulse Positive Grid Voltage [3]	340	340	v
Pulse Grid Current[3]	1.5	1.5	a
Pulse Duration	2.0	2.0	μs
Duty	0.0006	0.0006	
Pulse Driving Power [3]	697	735	w
Pulse Output Power[3]	306	506	kw
Pulse Output Voltage [3]	7.68	12.68	kv

APPLICATION

MECHANICAL

MOUNTING - The 3CPX1500A7 may be operated in any position. The SK-2200 socket is designed to hold the tube and make all base contacts, and for applications where forced-air cooling is to be used, the matching air chimney, SK-2216 is available.

COOLING - The 3CPX1500A7 may be either forced-air cooled or liquid-immersion cooled in a suitable dielectric coolant fluid. The maximum temperature limit for external tube surfaces and the anode core is 250°C, but it should be noted that, where long life and consistent performance are important design factors, operation at somewhat lower temperatures is normally beneficial. The air cooling data shown will maintain tube temperatures below 225°C with 50°C cooling air.

When the tube is liquid-immersed, circulation of the dielectric fluid will normally be required and the designer is cautioned to assure sufficient tube cooling for the maximum dissipation level likely to ever be reached with some safety factor allowance.

Base-to-Anode Air Flow (sea level)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H 0
500	7.5	0.10
1000	22.5	0.20
1500	35	0.41
Base-to-Anode Air Flow (10,000 ft.)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H 0
500	11.0	0.15
1000	32.5	0.29
1500	51	0.60

Note: 1) Tube mounted in SK-2200 Socket with SK-2216 Chimney.
2) An allowance of 25 watts has been made for grid dissipation and 50 watts for filament power.

ELECTRICAL

FILAMENT/CATHODE OPERATION - Pulse current capability of the 3CPX1500A7 is dependent on cathode temperature, which in turn is dependent on heater voltage. When the full rated (ib = 50 amperes maximum) anode current is required, the heater voltage should be operated at 5.5 volts and not deviate from this nominal value by more than plus or minus five percent. When a lower value of anode current (ib = 24 amperes maximum) is adequate for the application, the heater voltage should be reduced to 5.0 volts, plus or minus five percent, and tube life expectancy will be greatly improved. In cases where better life expectancy and consistent performance are factors, regulation to better than five percent will normally be beneficial at either heater voltage level. Voltage should be measured with a know accurate rms-responding meter.

ANODE CURRENT - For pulse service, either as a switch tube or modulator, or for voltage regulator applications, an anode current (during the pulse) of up to 50 amperes is available, with Ef = 5.5 volts, or up to 24 amperes with Ef = 5.0 volts. Peak current capability, pulse length, and duty factor are interrelated and the PULSE DERATING DATA should be consulted. For pure dc service, the anode current should be limited to 1.0 ampere.

HIGH VOLTAGE - For air operation, anode voltage should not exceed 10 kVdc at sea level. This value allows some safety factor, but does assume a clean tube with no buildup of dirt or grime across the insulating ceramic. At higher altitudes a reduction in voltage may be required to preclude the possibility of external tube flashover. When the tube is immersed in a liquid dielectric coolant with suitable insulating properties the allowable anode voltage is 15 kVdc at any altitude.

The operating voltages for this tube must be considered as potentially lethal and the equipment must be designed properly and operating precautions must be followed. The equipment must include safety enclosures for the high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors or covers are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

PLATE SURGE-LIMITING IMPEDANCE - Tubes such as the EIMAC 3CPX1500A7 are built with closely spaced electrodes. This results in high voltage gradients even at normal operating voltages. A high-energy arcover between electrodes may be destructive, and therefore a series impedance in the anode lead is recommended, or the anode supply should be designed so that it has sufficient self impedance to limit the short-circuit current to 10 times the maximum pulse-current rating. Normal overload protection techniques should also be used in the anode circuit to prevent tube damage in the event of a fault condition.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than about 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 3CPX-1500A7, operating at its rated voltages and currents, is a potential X-ray hazard, with only limited shielding afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

GRID OPERATION - The maximum rated dc grid bias voltage for the 3CPX1500A7 is -200 Vdc and the maximum grid dissipation rating is 25 watts. In normal applications the grid dissipation will not approach the maximum rating.

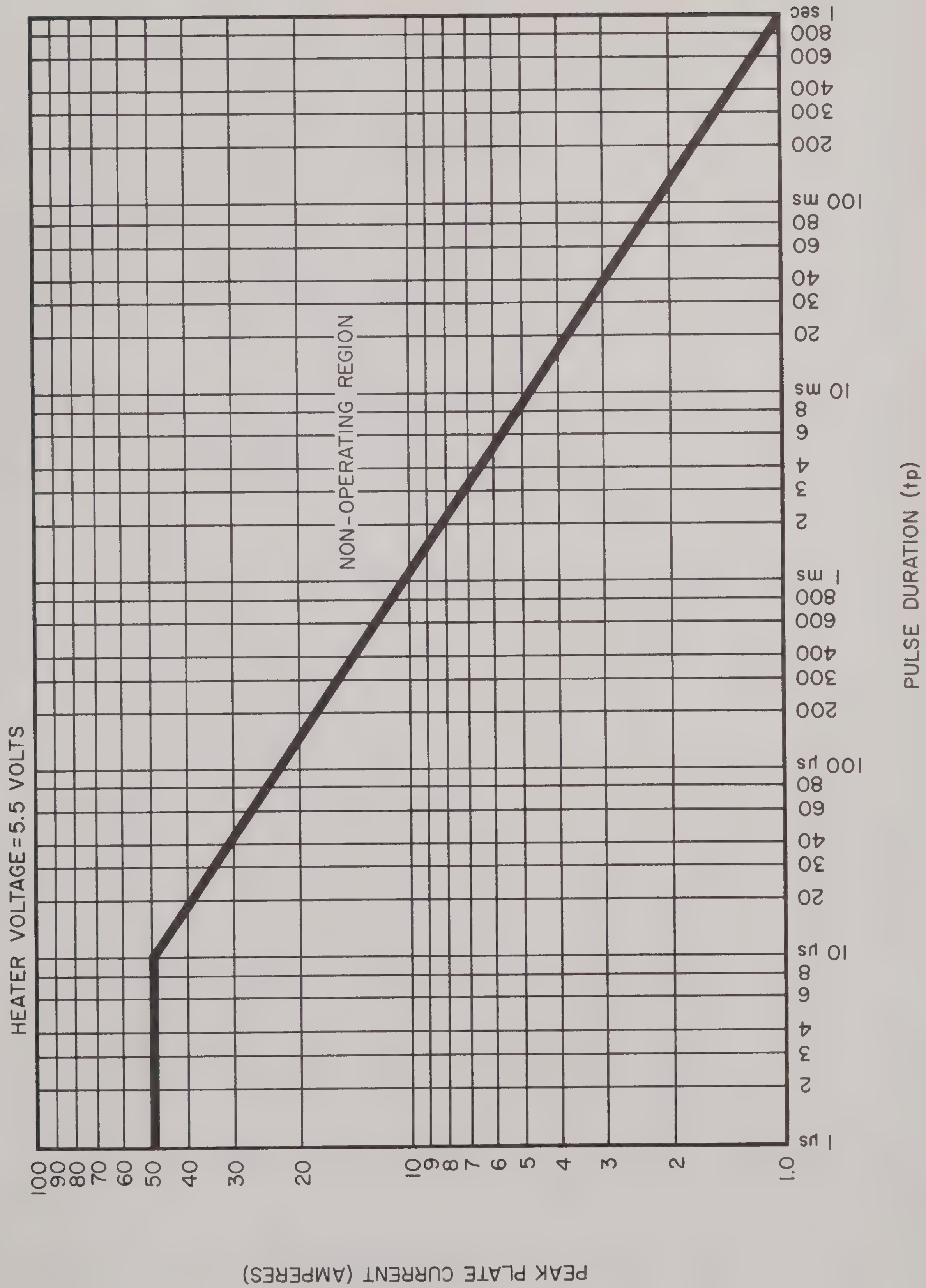
PLATE OPERATION - The anode of the 3CPX-1500A7 is nominally rated for the dissipation values shown on Page 2 depending on the type of cooling used. When the tube is immersed in a liquid dielectric coolant, with proper circulation, and (if required) provisions for dielectric fluid cooling, dissipation capability is actually limited only by tube temperature, especially in the seal areas and the anode core.

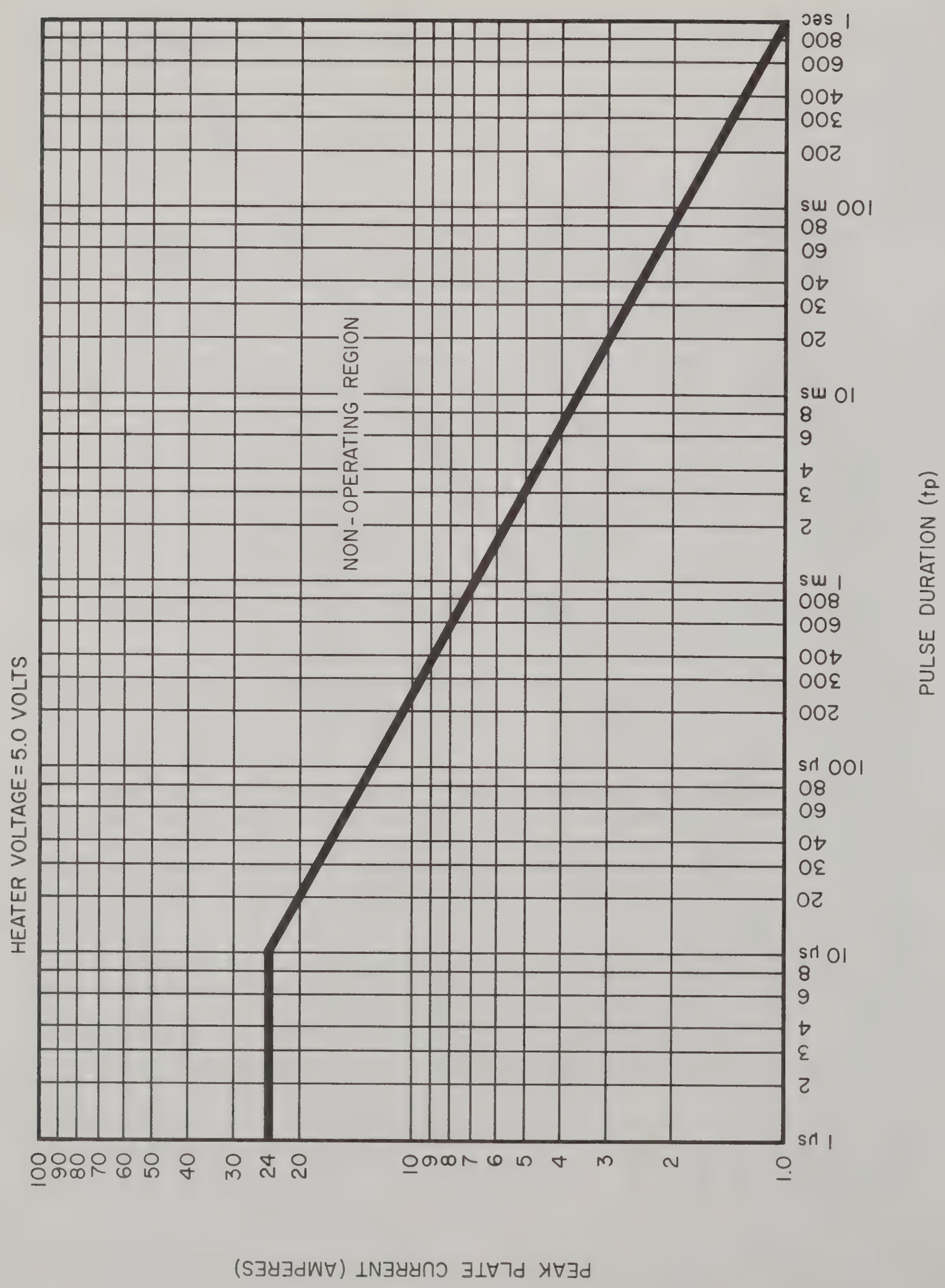
In pulse service average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. Actual dissipation may often exceed the calculated value, however, if pulse rise and fall rimes are appreciable compared to pulse duration. This occurs because long rise and fall times allow plate current to flow for longer periods in the high tube-voltage-drop region.

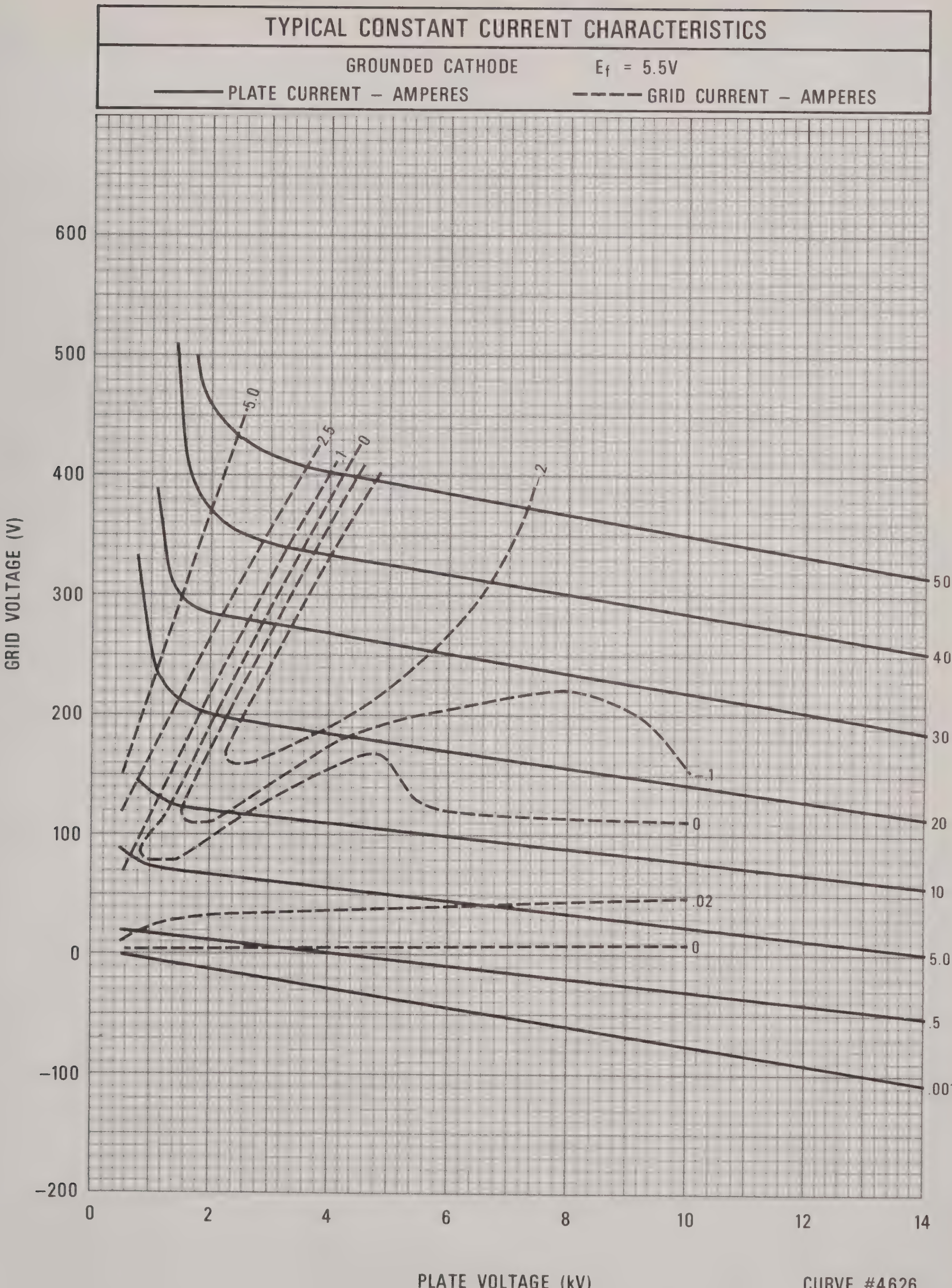
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time; manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

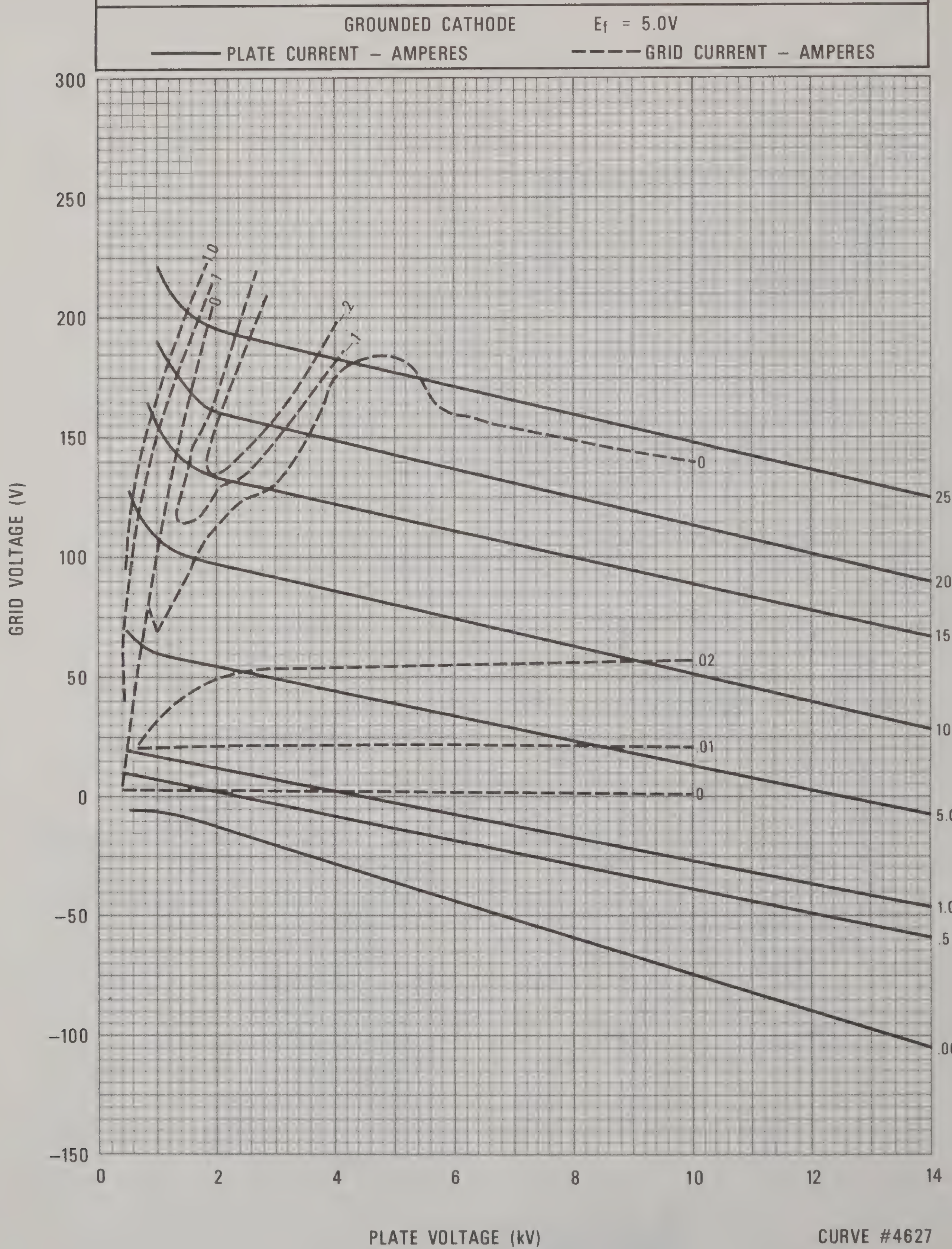

HEATER VOLTAGE = 5.5 VOLTS
NON-OPERATING REGION
PULSE DURATION (tp)
PEAK PLATE CURRENT (AMPERES)
1 μs 2 3 4 6 8 10 μs 20 30 40 60 80 100 μs 200 300 400 600 800 1 ms 2 3 4 6 8 10 ms 20 30 40 60 80 100 ms 200 300 400 600 800 1 sec
100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1.0


HEATER VOLTAGE = 5.0 VOLTS
NON-OPERATING REGION
PULSE DURATION (tp)
PEAK PLATE CURRENT (AMPERES)
1 µs 2 3 4 6 8 10 µs 20 30 40 60 80 100 µs 200 300 400 600 800 1 ms 2 3 4 6 8 10 ms 20 30 40 60 80 100 ms 200 300 400 600 800 1 sec
100 90 80 70 60 50 40 30 24 20 10 9 8 7 6 5 4 3 2 1.0

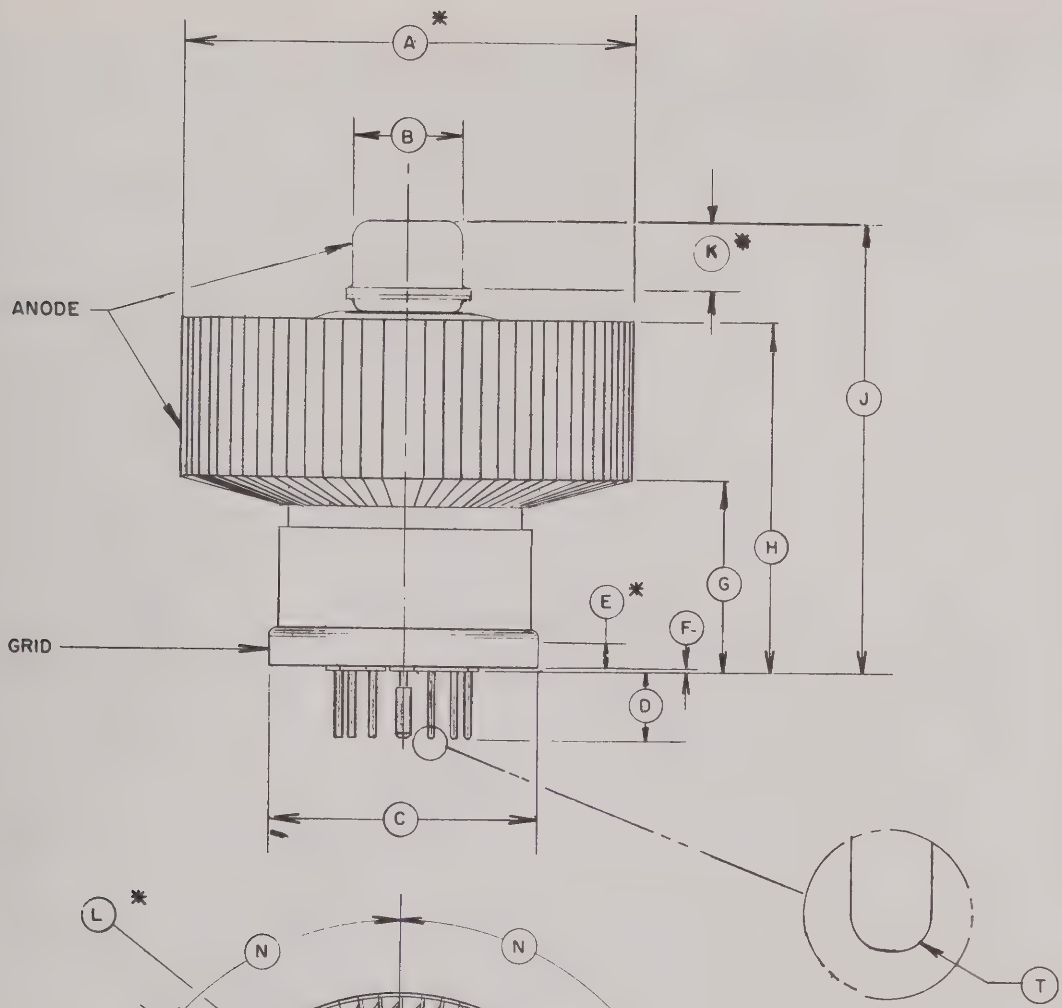

TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 5.5V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
600
500
400
300
200
100
0
−100
−200
0
2
4
6
8
10
12
14
PLATE VOLTAGE (kV)
50
40
30
20
10
5.0
.5
.001
5.0
2.5
1
0
2
1
0
.02
0

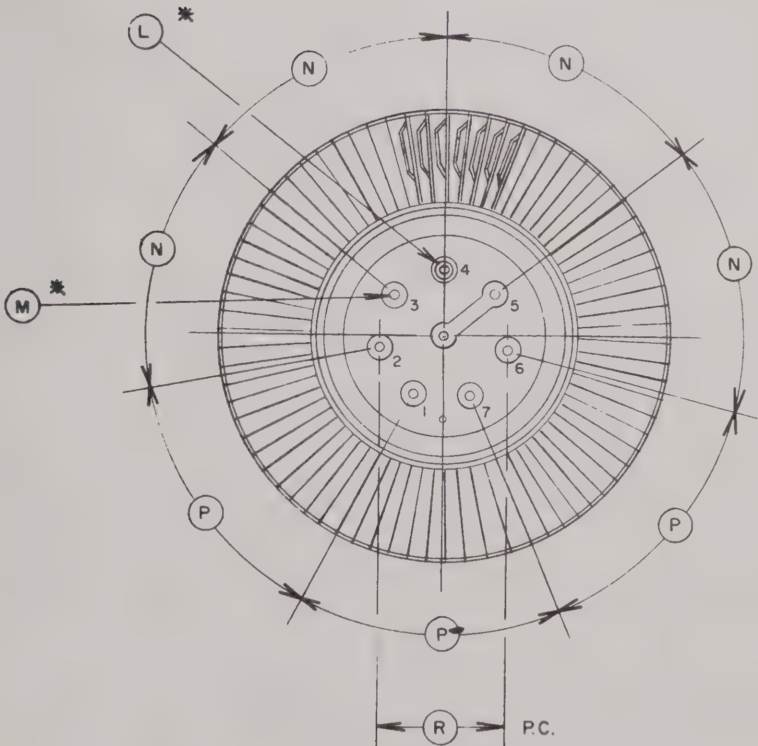
CURVE #4626

TYPICAL CONSTANT CURRENT CHARACTERISTICS



CURVE #4627





PIN CONNECTIONS

1 - HEATER
5 - HEATER
2 - 3 - 4 - 6 - 7 CATHODE

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.350	3.380	- -	85.09	85.85	- -
B	0.810	0.820	- -	20.57	20.83	- -
C	1.995	2.015	- -	50.67	51.18	- -
D	0.438	0.562	- -	11.13	14.27	- -
E	0.235	- -	- -	5.97	- -	- -
F	0.000	0.040	- -	0.00	1.02	- -
G	1.350	1.475	- -	34.29	37.46	- -
H	2.550	2.675	- -	64.77	67.94	- -
J	3.250	3.420	- -	82.55	86.87	- -
K	0.470	0.530	- -	11.94	13.46	- -
L	0.120	0.127	- -	3.05	3.23	- -
M	0.056	0.062	- -	1.42	1.57	- -
N	- -	- -	51°	- -	- -	51°
P	- -	- -	52°	- -	- -	52°
R	- -	- -	1.000	- -	- -	25.40
T	0.020R	- -	- -	0.51 R	- -	- -

NOTES:

1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE
3. DIMENSION T APPLIES TO ALL BUT CENTER PIN.

3CW20,000A3

WATER-COOLED MEDIUM-MU POWER TRIODE

TECHNICAL DATA

The EIMAC 3CW20,000A3 is a ceramic/metal power triode intended primarily for use as a power oscillator in industrial-heating applications. It is also recommended for use as a grounded-grid FM amplifier, as a conventional plate-modulated amplifier, or as a linear amplifier.

The anode dissipation rating is 20,000 watts with water cooling.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.4	V
Current, at 7.5 V	100	A
Amplification Factor (Average)	20	
Direct Interelectrode Capacitances[2]		
Cin	53	pF
Cout	1.35	pF
Cgp	34	pF
Frequency of Maximum Ratings (CW)	140	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, Coaxial
Recommended Air System Socket	EIMAC SK-1300
Operating Position	Vertical, base up or down
Cooling	Water and Forced Air
Maximum Operating Temperature:	
Envelope and Ceramic/Metal Seals	250°C
Maximum Overall Dimensions:	
Length	10.21 in; 259.3 mm
Diameter	4.65 in; 118.1 mm
Net Weight	12 lbs; 5.5 kg

 Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER PLATE-MODULATED
Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	5500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	13.5	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

DC Plate Voltage	4000	5000	Vdc
DC Grid Voltage	-480	-600	Vdc
DC Plate Current	3.0	3.0	Adc
DC Grid Current	660	550	mAdc
Driving Power	530	515	W
Plate Output Power	9.7	12.4	kW

RADIO-FREQUENCY LINEAR AMPLIFIER
Grounded-Grid, Class AB2

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	250	WATTS

1. Adjust to give specified zero-signal dc plate current.

TYPICAL OPERATION

DC Plate Voltage	6000	7000	Vdc
DC Grid Voltage [1]	-270	-325	Vdc
Zero-Sig. Plate Current	500	500	mAdc
Max-Sig DC Plate Current	4.0	4.0	Adc
Max-Sig DC Grid Current	300	250	mAdc
Peak RF Grid Voltage	540	585	v
Driving Power	1900	2050	W
Plate Output Power	18	20	kW

RADIO-FREQUENCY INDUSTRIAL OSCILLATOR
Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION, Optimum Load

DC Plate Voltage	6000	7000	Vdc
DC Grid Voltage	-575	-670	Vdc
DC Plate Current	4.0	4.0	Adc
DC Grid Current	610	670	mAdc
Plate Input Power	24	28	kW
Plate Output Power	18.9	22.4	kW

RADIO-FREQUENCY POWER AMPLIFIER
Grounded-Grid, Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

DC Plate Voltage	6000	7000	Vdc
DC Grid Voltage	-535	-625	Vdc
DC Plate Current	4.0	4.0	Adc
DC Grid Current	545	530	mAdc
Driving Power	3700	4100	W
Plate Output Power	20.5	24.5	kW

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves or actual measurement. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current at 7.5 Volts	94.0	104.0	A
Interelectrode Capacitance (grounded cathode connection)[1]			
Cin	48.0	58.0	pF
Cout	1.2	1.5	pF
Cgp	30.0	38.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 3CW20,000A3 must be operated vertically, anode down or up, and should be protected from shock and vibration.

COOLING - The anode of the 3CW20,000A3 is cooled by circulating water through the integral anode water jacket. The cooling table shows minimum water-flow rates at various plate dissipation levels and assumes a temperature rise for the water of 10°C. Inlet water temperature should never exceed 55°C and outlet water temperature should never exceed 70°C. Where a liquid coolant other than water is used, the difference in cooling characteristics should be carefully considered and taken into account. Maximum system pressure must not exceed 50 psi.

Minimum Cooling Water-Flow Requirements		
Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop Approx. psi
10	11.0	11.5
15	12.0	13.5
20	14.0	17.0

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 $K\Omega/cm^3$, and preferably above 250 $K\Omega/cm^3$. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Forced-air cooling of the base is also required, with 30 to 50 cfm of air at 50°C maximum directed up into and around the base of the tube to cool the grid and filament contact areas.

Both anode and base cooling should be applied before or simultaneously with electrode voltages, including the filament, and should normally be maintained for a short period of time after all voltages are removed to allow for tube cooldown.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the terminals with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 3CW20,000A3 is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 3CW20,000A3 by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate.

INPUT CIRCUIT - When the 3CW20,000A3 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of two or more.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

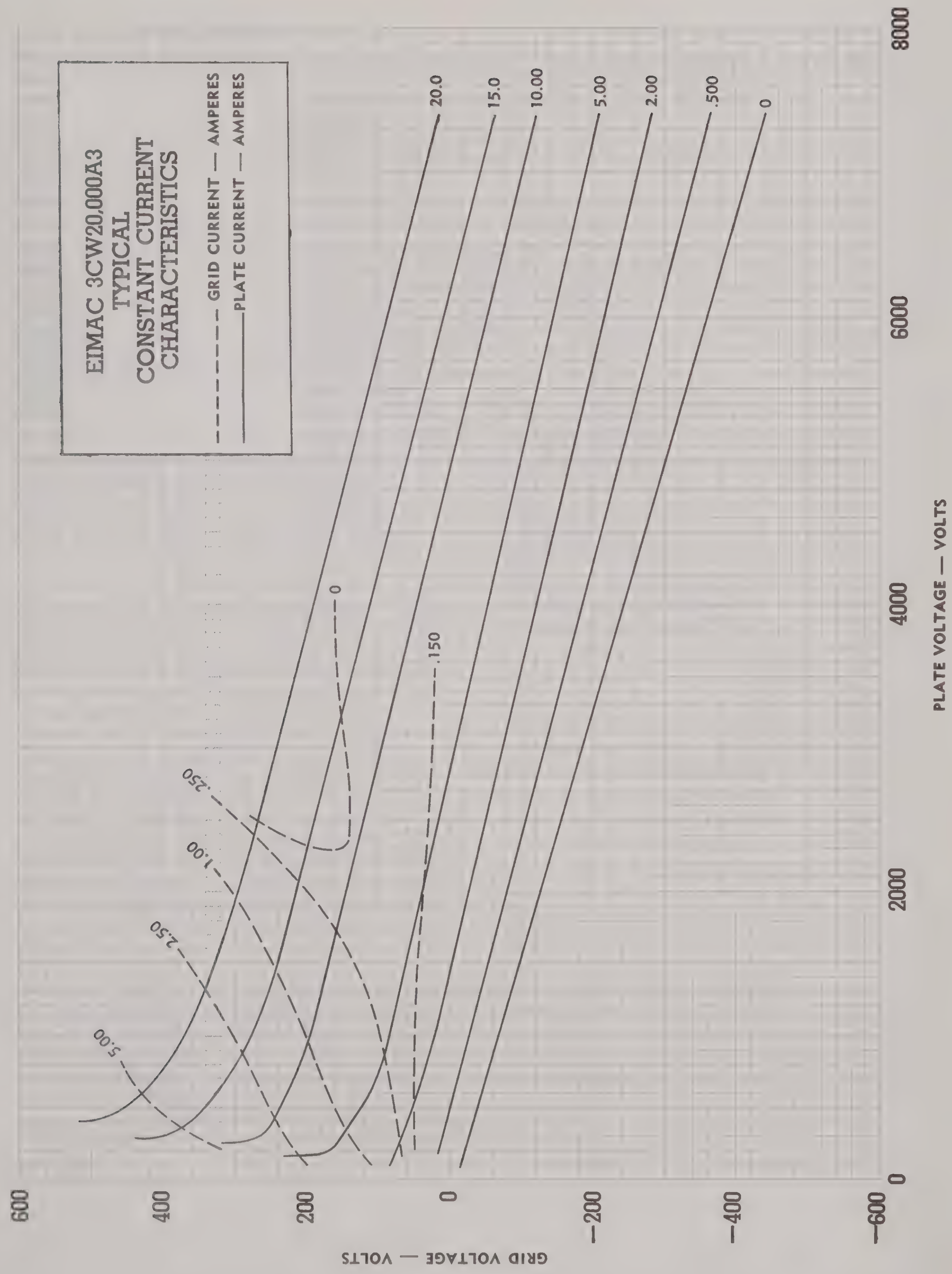
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

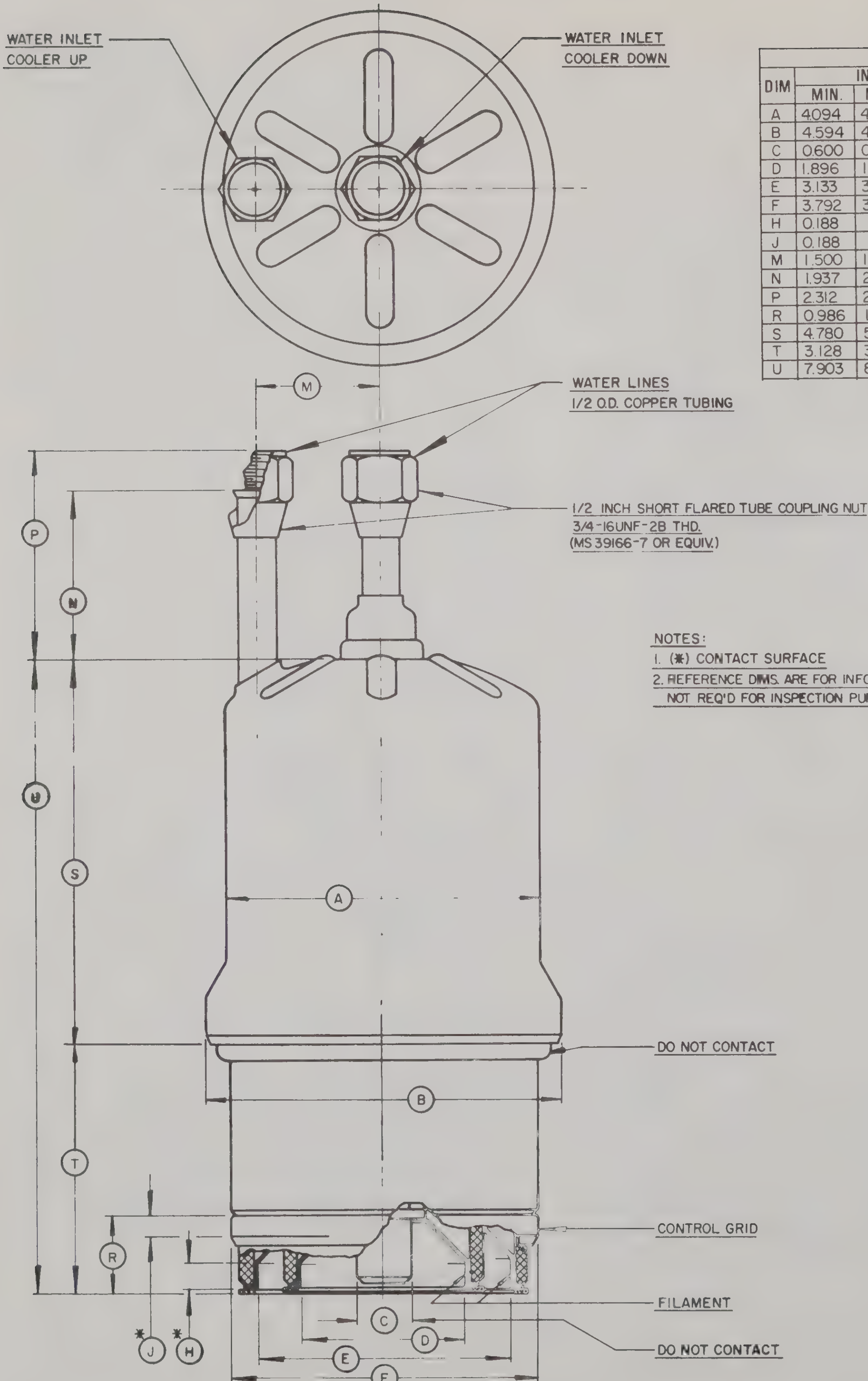
Many EIMAC power tubes, such as the 3CW-20,000A3, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--- the more power invloved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate over-current interlock and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 3CW20,000A3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GRID CURRENT — AMPERES
PLATE CURRENT — AMPERES
20.0
15.0
10.00
5.00
2.00
.500
0
5.00
2.50
1.00
.250
.150
0
PLATE VOLTAGE — VOLTS
0
2000
4000
6000
8000
GRID VOLTAGE — VOLTS
600
400
200
0
−200
−400
−600



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156	- -	104.0	105.6	- -
B	4.594	4.656	- -	116.7	118.3	- -
C	0.600	0.760	- -	15.2	19.3	- -
D	1.896	1.936	- -	48.2	49.2	- -
E	3.133	3.173	- -	79.6	80.6	- -
F	3.792	3.832	- -	96.3	97.3	- -
H	0.188	- -	- -	4.8	- -	- -
J	0.188	- -	- -	4.8	- -	- -
M	1.500	1.750	- -	38.1	44.4	- -
N	1.937	2.187	- -	49.2	55.5	- -
P	2.312	2.812	- -	58.7	71.4	- -
R	0.986	1.050	- -	25.0	26.7	- -
S	4.780	5.025	- -	121.4	127.6	- -
T	3.128	3.428	- -	79.4	87.1	- -
U	7.903	8.403	- -	200.7	213.4	- -

NOTES:
1. (*) CONTACT SURFACE
2. REFERENCE DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.

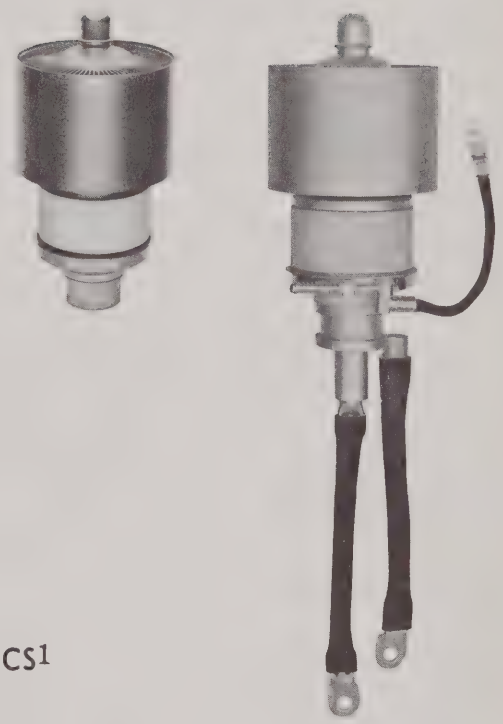
3CX3000A7
8162
3CX3000F7
HIGH-MU
AIR COOLED
POWER TRIODES

TECHNICAL DATA

The EIMAC 3CX3000A7 high-mu forced-air cooled power triode provides relatively high power output as an amplifier, oscillator, or modulator at low plate voltages. The tube has a low inductance cylindrical filament-stem structure which readily becomes part of a linear filament tank circuit for VHF operation. The grid provides good shielding between the input and output circuits for grounded-grid applications and conveniently terminates in a ring between the plate and filament terminals.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded-grid operation is attractive, since a power gain of over 20 times can be obtained.

The 8162/3CX3000F7 tube is identical except for the addition of flexible leads on the base for grid and filament connections which can simplify socketing in low-frequency applications.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten	
Voltage	7.5 V
Current @ 7.5 V (3CX3000A7)	51.5 A
(3CX3000F7)	50.5 A
Amplification Factor (Average)	160
Direct Interelectrode Capacitances (grounded filament)[2]	
Cin	38.0 pF
Cout	0.6 pF
Cgp	24.0 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	38.0 pF
Cout	24.0 pF
Cpk	0.6 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

Frequency of Maximum Rating:	3CX3000A7	110 MHz
	3CX3000F7	30 MHz

MECHANICAL

Maximum Overall Dimensions:

Length (3CX3000A7)	9.000 in; 227.60 mm
(3CX3000F7, incl. fil. leads)	18.437 in; 468.30 mm
Diameter (both types)	4.156 in; 105.56 mm
Operating Position	Vertical, base up or down
Net Weight: (3CX3000A7) (Approx.)	6.2 lb; 2.8 kg
(3CX3000F7) (Approx.)	7.0 lb; 3.2 kg
Cooling	Forced Air
Base (3CX3000A7)	Special Coaxial
(3CX3000F7)	Special with Flying Leads

Maximum Operating Temperature:

Anode Core and Ceramic/Metal Seals	250°C
3CX3000F7 Filament Lead/Tube Base Junctions	150°C

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4000	4800	4800	Vdc
Zero-Signal Plate Current[1]	0.25	0.35	0.35	Adc
Single-Tone Plate Current	2.00	1.68	2.00	Adc
Single-Tone Grid Current[1]	0.61	0.46	0.60	Adc
Peak Driving Power	420	293	410	w
Plate Dissipation	2285	2275	2775	W
Single-Tone Plate Output Power	6030	6000	7266	W
Resonant Load Impedance	1210	1720	1425	Ω
Driving Impedance	47.5	50.0	46.3	Ω

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Grid Driven, Carrier Conditions

Plate Voltage	4000	Vdc
Zero-Signal Plate Current[1]	0.25	Adc
DC Plate Current	0.74	Adc
DC Grid Current[1]	0.13	Adc
Peak rf Grid Voltage[1]	85.0	v
Peak Driving Power[1]	11.5	w
Plate Dissipation	1830	W
Single-Tone Plate Output Power	1130	W
Resonant Load Impedance	1750	Ω
Peak rf Plate Voltage	2000	v

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM, Cathode Driven
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz for 3CX3000A7, to 30 MHz for 3CX3000F7)

Plate Voltage	3500	4800	Vdc
Grid Voltage	-50	-60	Vdc
Plate Current	1.30	1.54	Adc
Grid Current[1]	0.42	0.48	Adc
Peak rf Cathode Voltage[1]	220	267	v
Calculated Driving Power[1]	310	435	W
Plate Dissipation	985	1480	W
Useful Output Power[2]	3300	5500	W

1. Approximate value.
2. Output circuit and filter loss of 10% assumed.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
Class AB_2, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.
2. Per tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	Vdc
Zero-Signal Plate Current[1]	0.50	Adc
Max. Signal Plate Current	3.58	Adc
Max. Signal Grid Current[1]	0.58	Adc
Peak af Grid Voltage[2]	190	v
Peak Driving Power[3]	115	w
Max. Signal Plate Dissipation	1850	W
Plate Output Power	10,500	W
Load Resistance (plate to plate)	2720	Ω

3. Nominal drive power is one-half peak power.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts (3CX3000A7)	49.0	54.0	A
(3CX3000F7)	48.0	53.0	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	30.0	45.0	pF
Cout	---	1.0	pF
Cgp	20.0	28.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	30.0	45.0	pF
Cout	20.0	28.0	pF
Cpk	---	1.0	pF
Zero Bias Plate Current (E_b = 5000 volts)	0.36	0.52	A
Cut-off Bias (E_b = 5000 volts, I_b = 1.0 mAdc)	---	-45.0	V

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CX3000A7 and 3CX3000F7 must be mounted vertically, base down or up at the convenience of the circuit designer. The filament connections to the 3CX3000A7 should be made through spring collets. These are available from EIMAC with the following part numbers:

149575 Inner line collet
149576 Outer line collet

Reasonable care should be taken that these collets do not impart undue strain to the terminals or the base of the tube.

COOLING - The maximum temperature rating for the anode core and the ceramic/metal seal areas of either tube is 250°C, and sufficient forced-air cooling must be provided to assure operation at safe tube temperatures. Tube life is usually prolonged if cooling in excess of absolute minimum requirements is provided for cooler tube temperatures.

The filament leads of the 3CX3000F7 are attached to the tube with soft solder, and care must therefore be taken to supply sufficient

cooling to this area of the tube to maintain temperatures below 150°C to avoid melting or loosening of these leads.

Minimum air flow requirements to maintain anode core and ceramic/metal seal areas below 225°C at sea level with an inlet-air temperature of 50°C are tabulated for air-flow in the base-to-anode and anode-to-base directions. At higher ambient temperatures, frequencies above 30 MHz, or at higher altitudes, a greater quantity of air will be required.

With air flowing in a base-to-anode direction, and with the specified air also flowing past the base section of the tube, no additional base cooling of either type is normally required. With air flowing in an anode-to-base direction, both types require additional cooling air directed into the filament stem structure, between the inner and outer filament terminals, in the amount of 5 cfm minimum, directed by an appropriate air nozzle or pipe.

It is suggested that temperatures, especially in the base area of the tube, be monitored in any new installation to insure proper cooling. Temperatures may be measured with any of the available temperature-sensing paint or crayon materials.

Base-to-Anode Air Flow				
	Sea Level		10,000 Feet	
Anode Dissipation watts	Air Flow CFM	Pressure Drop Inches water	Air Flow CFM	Pressure Drop Inches water
2000	49	0.31	71	0.45
3000	85	0.72	124	1.40
4000	127	1.40	185	2.55
Anode-to-Base Air Flow				
2000	54	0.37	79	0.68
3000	106	1.1	155	1.90
4000	178	2.50	260	4.50

ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line fluctuations of from 7.12 to 7.87 volts.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the heater. The circuit should be so arranged that rf drive cannot be applied in the absence of normal plate voltage.

INPUT CIRCUIT - When operated as a grounded-grid rf amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single-ended amplifier, and depending on the application, it is suggested the network have a "Q" of at least 2, and higher if possible.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as these, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal cooling airflow interlock and plate over-current interlock it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

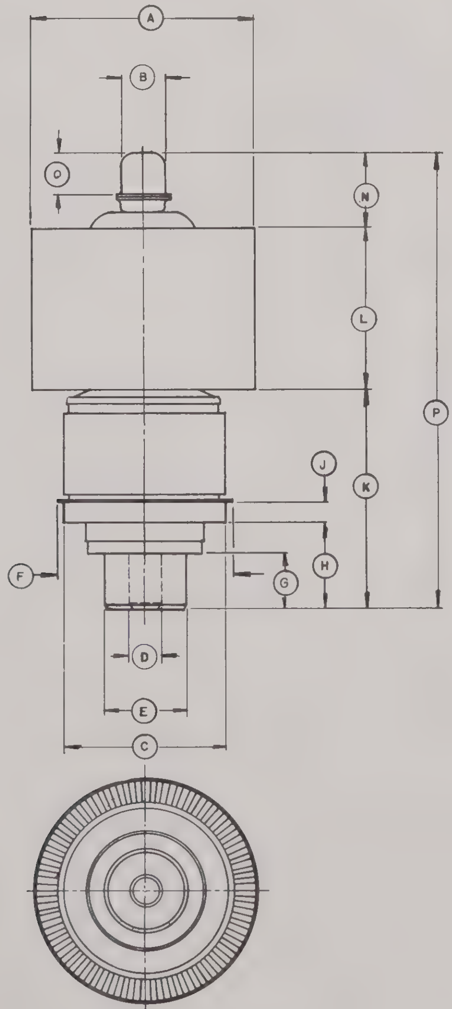
HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers.

The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

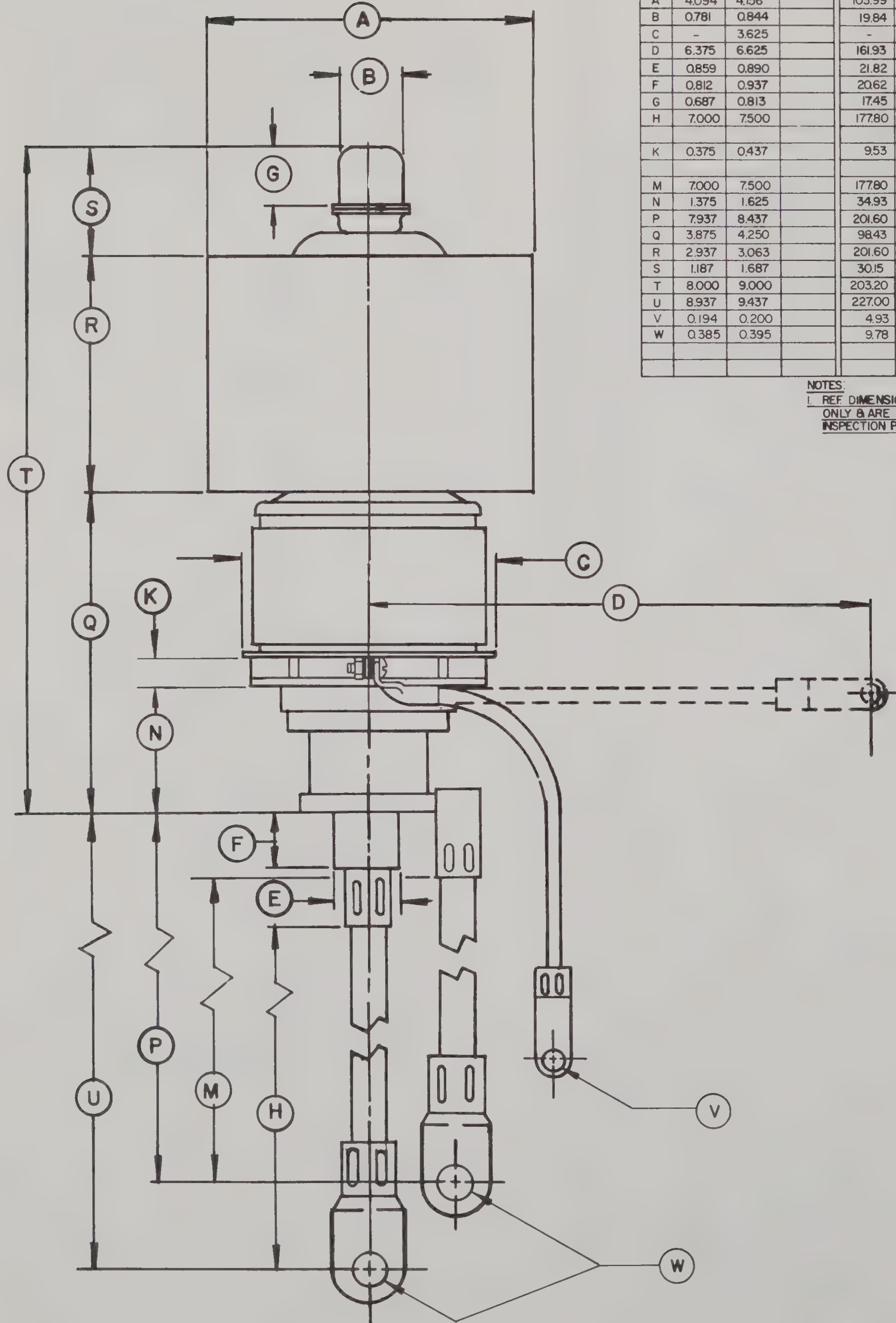
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



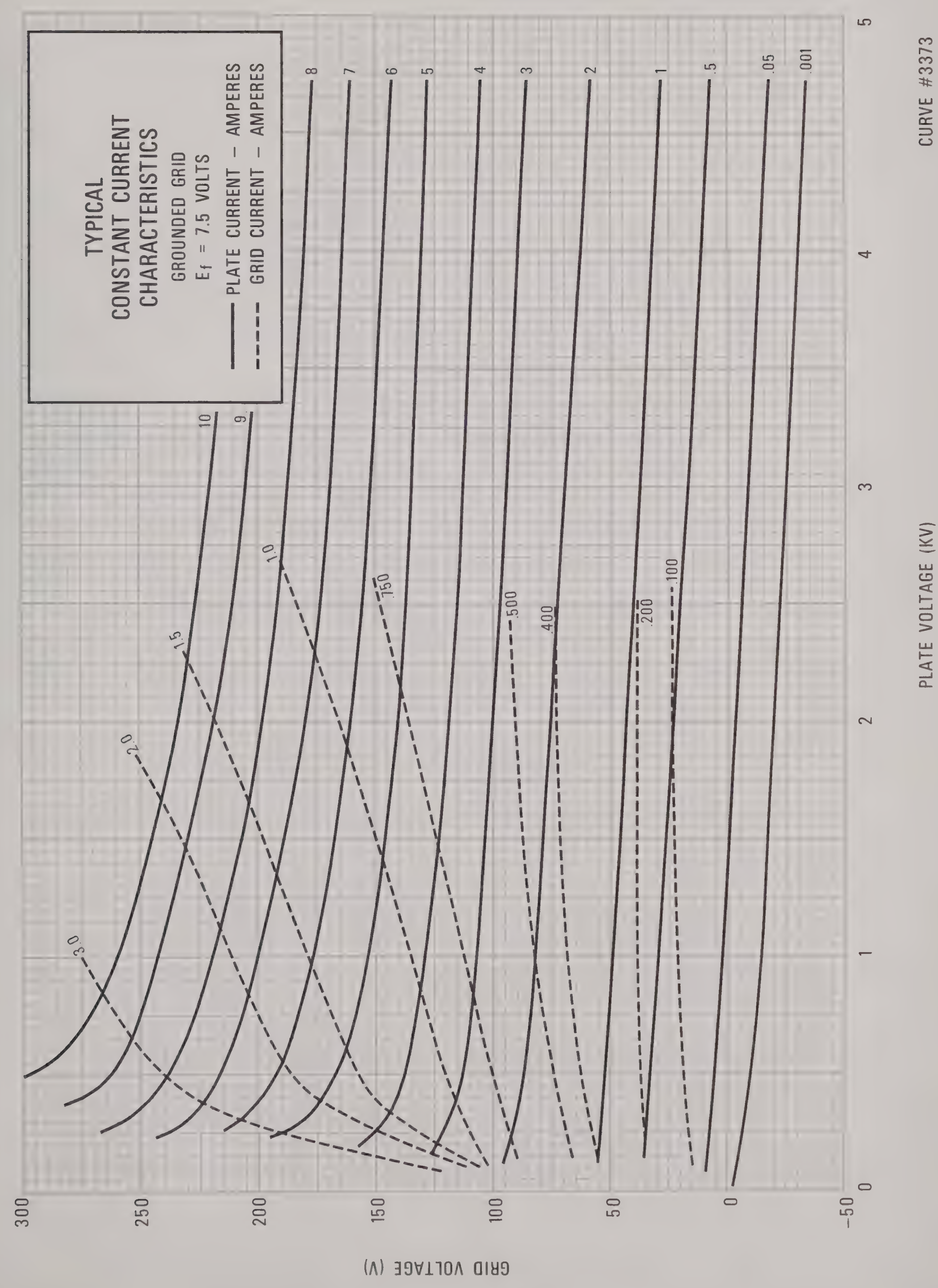
DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156	- -	103.99	105.56	- -
B	0.781	0.844	- -	19.83	21.44	- -
C	2.990	3.010	- -	75.95	76.45	- -
D	0.615	0.635	- -	15.62	16.13	- -
E	1.490	1.510	- -	37.85	38.35	- -
F	- -	3.625	- -	- -	92.08	- -
G	0.813	0.937	- -	20.65	23.80	- -
H	1.375	1.625	- -	34.92	41.28	- -
J	0.391	0.422	- -	9.93	10.72	- -
K	3.875	4.250	- -	98.43	107.95	- -
L	2.937	3.063	- -	74.60	77.80	- -
N	1.187	1.687	- -	30.15	42.85	- -
P	8.000	9.000	- -	203.20	228.60	- -
Q	0.687	0.813	- -	17.45	20.65	- -

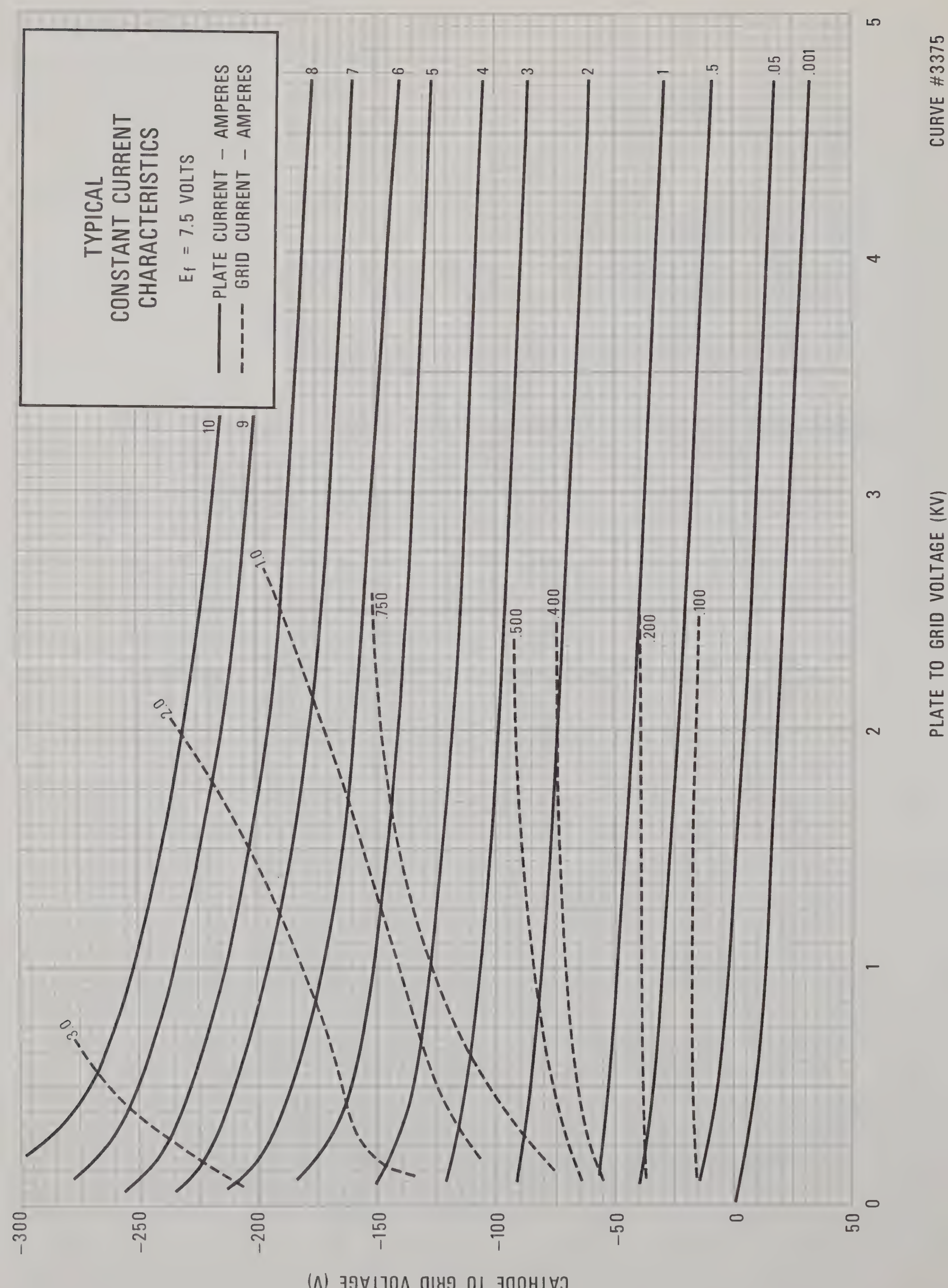
NOTES.
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX	REF.	MIN	MAX.	REF
A	4.094	4.156		103.99	105.56	
B	0.781	0.844		19.84	21.44	
C	–	3.625		–	92.08	
D	6.375	6.625		161.93	168.28	
E	0.859	0.890		21.82	22.61	
F	0.812	0.937		20.62	23.80	
G	0.687	0.813		17.45	20.65	
H	7.000	7.500		177.80	190.50	
K	0.375	0.437		9.53	11.10	
M	7.000	7.500		177.80	190.50	
N	1.375	1.625		34.93	41.28	
P	7.937	8.437		201.60	214.30	
Q	3.875	4.250		98.43	107.95	
R	2.937	3.063		201.60	214.30	
S	1.187	1.687		30.15	42.85	
T	8.000	9.000		203.20	228.60	
U	8.937	9.437		227.00	239.70	
V	0.194	0.200		4.93	5.08	
W	0.385	0.395		9.78	10.03	

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.5
1.0
.750
.500
.400
.200
.100
300
250
200
150
100
50
0
−50
GRID VOLTAGE (V)
0
1
2
3
4
5
PLATE VOLTAGE (KV)
CURVE #3373


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PLATE TO GRID VOLTAGE (KV)
CATHODE TO GRID VOLTAGE (V)
CURVE #3375

TECHNICAL DATA

4CW50,000E

WATER COOLED POWER TETRODE

The EIMAC 4CW50,000E is a ceramic/metal, liquid-cooled power tetrode intended for use at the 50 to 100 kilowatt output power level. This tube is characterized by low input and feedback capacitances and low internal lead inductances. A rugged mesh thoriated tungsten filament provides adequate emission over the long operating life. It is recommended for use as a Class C rf amplifier or oscillator, a Class AB rf linear amplifier or a Class AB push-pull af amplifier or modulator. The 4CW50,000E is also useful as a plate and screen modulated Class C rf amplifier. The liquid-cooled anode is rated at 50 kilowatts plate dissipation.

Shown with SK-2050 water jacket removed.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh	
Voltage	12.0 ± 0.6 V
Current, at 12.0 volts	215 A
Amplification Factor (Average);	
Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)	
Cin	310 pF
Cout	52 pF
Cgp	0.7 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:	
Length (with water jacket)	12.75 in; (324 mm)
Diameter	9.53 in; (242 mm)
Net Weight (less water jacket)	35 lb; (15.9 kg)
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals and terminals	250°C
Cooling	Liquid and Forced air
Base	Special
Recommended Socket	EIMAC SK-2000 Series
Recommended Water Jacket	EIMAC SK-2050

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions.

Plate Voltage	10.0	kVdc
Screen Voltage	1.8	kVdc
Grid Voltage [1]	-260	Vdc
Zero-Signal Plate Current	3.4	Adc
Single Tone Plate Current	9.14	Adc
Peak rf Grid Voltage [2]	230	v
Resonant Load Impedance	600	Ω
Plate Dissipation	35	kW
Plate Output Power	57	kW

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	15.0	15.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-800	-800	Vdc
Plate Current	9.0	11.5	Adc
Screen Current [1]	0.9	0.83	Adc
Grid Current [1]	125	160	mAdc
Peak rf Grid Voltage [1]	880	925	v
Calculated Driving Power [1]	110	150	W
Plate Dissipation	25	36	kW
Plate Output Power	110	137	kW
Resonant Load Impedance	820	615	Ω

1. Approximate value

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION [1]	33,000	WATTS
SCREEN DISSIPATION [2]	1,500	WATTS
GRID DISSIPATION [2]	400	WATTS

1. Corresponds to 50,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	9.0	14.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-600	Vdc
Plate Current	7.41	9.25	Adc
Screen Current [3]	0.69	1.15	Adc
Grid Current	0.333	0.833	Adc
Peak af Screen Voltage [3] (100% modulation)	750	750	v
Peak rf Grid Voltage [3]	750	820	v
Calculated Driving Power	250	685	W
Plate Dissipation	12.5	21.5	kW
Plate Output Power	54.2	110	kW

3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	15.0	kVdc
Screen Voltage	1.25	kVdc
Grid Voltage [1/3]	-280	Vdc
Zero-Signal Plate Current	5.0	Adc
Max. Signal Plate Current	18.6	Adc
Max. Signal Screen Current [1]	0.6	Adc
Peak af Grid Voltage [2]	275	v
Peak Driving Power	0	w
Max. Signal Plate Dissipation [2]	41.7	kW
Plate Output Power	195	kW
Load Resistance (plate to plate)	1870	Ω

1. Approximate value.
2. Per tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 12.0 volts	200	230	A
Interelectrode Capacitances (grounded cathode connection)			
Input	290	330	pF
Output	47	57	pF
Feedback	---	1.0	pF
Interelectrode Capacitances (grounded grid connection)			
Input	130	150	pF
Output	47	57	pF
Feedback	---	0.5	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CW50,000E must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET - The EIMAC socket type SK-2011 is recommended for use with the 4CW50,000E.

COOLING - Anode cooling is accomplished by circulating water through the SK-2050 water jacket. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation * (kilowatts)	Water Flow		Press. Drop	
	GPM 1	LPM 2	PSI 3	kPa 4
10	3.0	11.4	2.0	13.8
20	5.0	18.9	3.0	20.7
30	6.5	24.6	4.0	27.6
40	8.5	32.2	5.2	35.8
50	10.5	39.8	6.5	44.8

1 Gallons per minute
2 Liters per minute
3 Pounds per Sq. In.
4 Kilopascals

*This tabulation has made allowance for an additional possible 4400 watts dissipation by the filament and grids.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 80 psi.

A major factor affecting long life of water cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 K ohms/cm^3, and preferably above 250 K ohms/cm^3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes.

Separate cooling of the tube base is required and is accomplished by directing approximately 200 cfm of air around the base of the tube with appropriately placed air nozzles.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the socket with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 4CW50,000E is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW50,000E by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is

done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW50,000E. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate. This point should be periodically checked to maintain proper operation.

GRID OPERATION - The 4CW50,000E control grid is rated at 400 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on rms screen voltage, and rms screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CW50,000E may exhibit reversed screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed.

PLATE DISSIPATION - The plate dissipation of 50 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW50,000E is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 33,300 watts.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant, flow temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with the 4CW50,000E are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CW50,000E, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

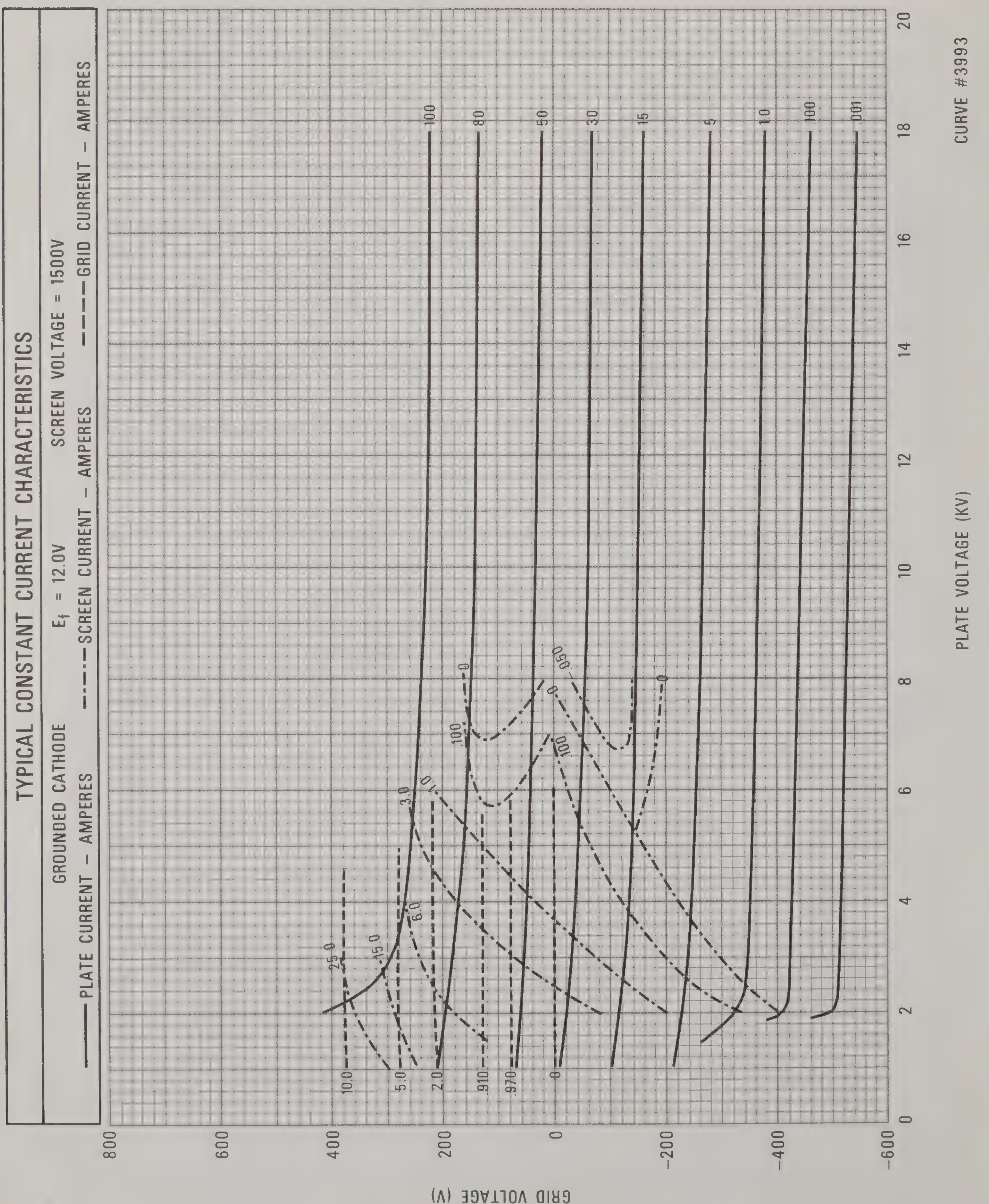
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CW-50,000E, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry --- the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate over-current interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 12.0V
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE #3993
0
2
4
6
8
10
12
14
16
18
20
800
600
400
200
0
-200
-400
-600
100
80
50
30
15
5
1.0
.100
.001
25.0
15.0
10.0
5.0
6.0
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1.0
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0
100
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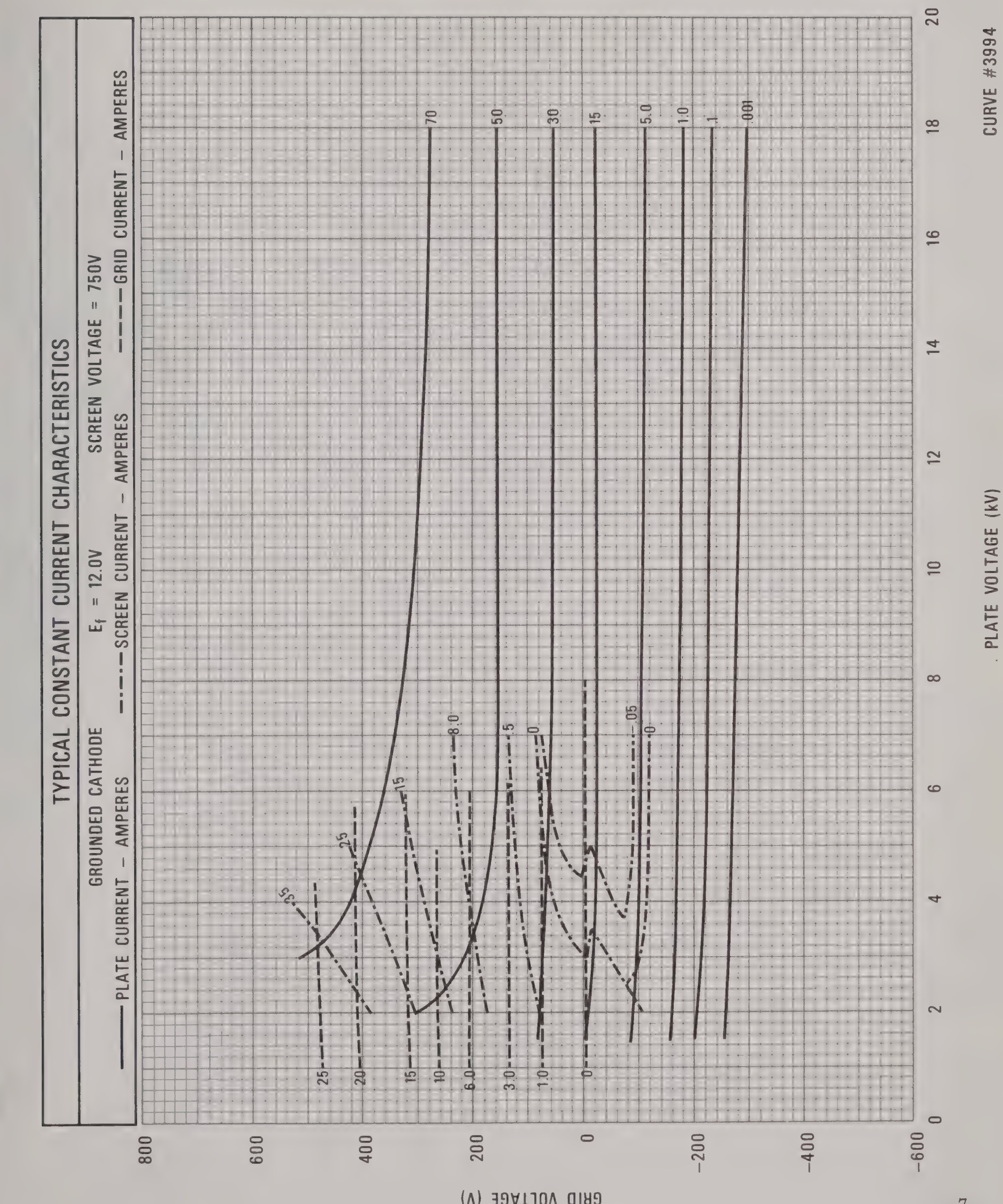
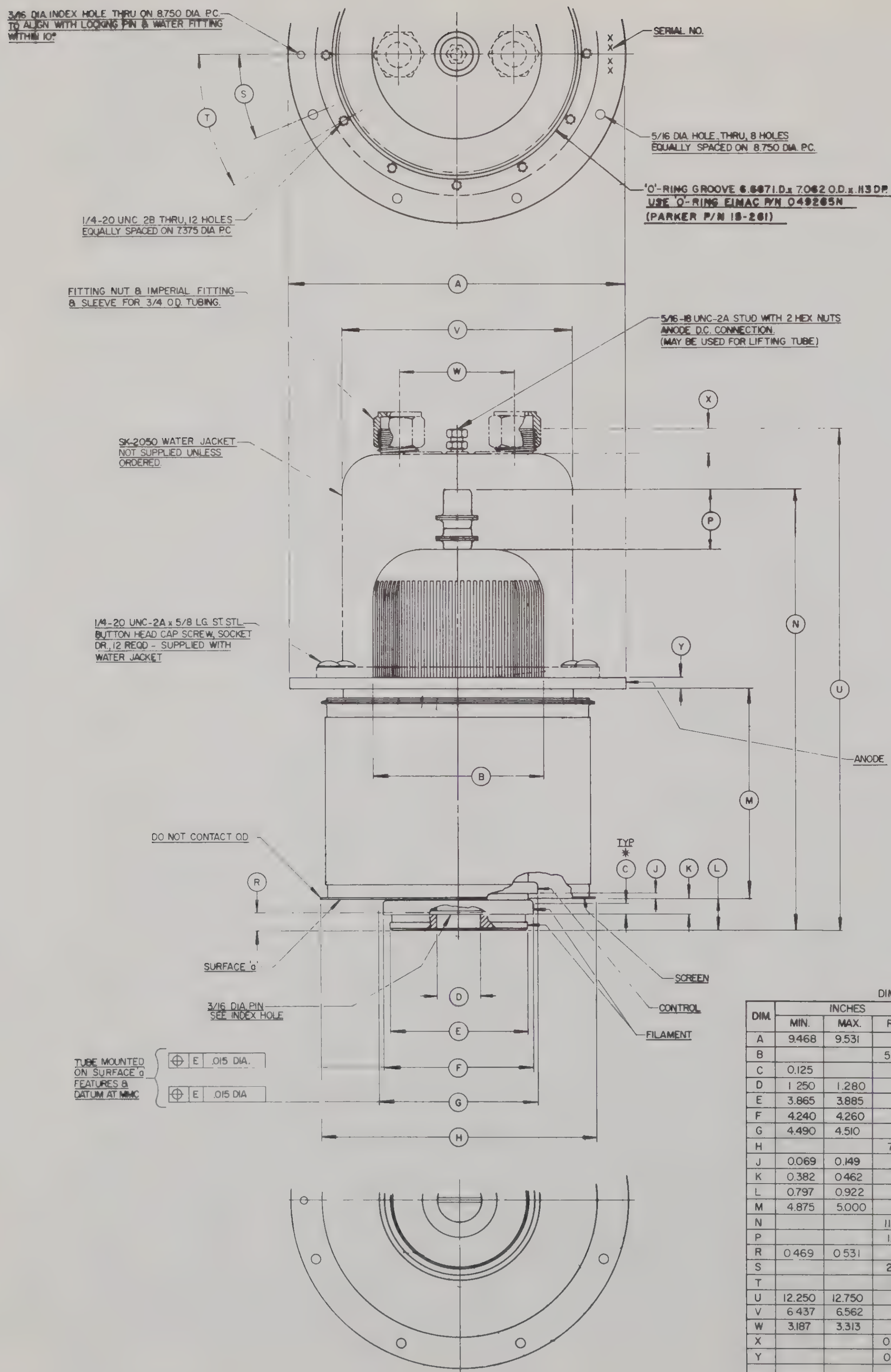


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 12.0V
SCREEN VOLTAGE = 750V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
800
600
400
200
0
-200
-400
-600
PLATE VOLTAGE (kV)
0
2
4
6
8
10
12
14
16
18
20
70
50
30
15
5.0
1.0
.1
.001
25
20
15
10
6.0
3.0
1.0
0
8.0
.5
.05
CURVE #3994



DIMENSIONAL DATA

DIM.	INCHES MIN.	INCHES MAX.	INCHES REF.	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF.
A	9.468	9.531		240.49	242.09	
B			5.000			127.00
C	0.125			3.18		
D	1.250	1.280		31.75	32.51	
E	3.865	3.885		98.17	98.68	
F	4.240	4.260		107.70	108.20	
G	4.490	4.510		114.05	114.55	
H			7.750			196.85
J	0.069	0.149		1.75	3.78	
K	0.382	0.462		9.70	11.73	
L	0.797	0.922		20.24	23.42	
M	4.875	5.000		123.83	127.00	
N			11.500			292.10
P			1.437			36.50
R	0.469	0.531		11.91	13.49	
S			22.5°			22.5°
T			30°			30°
U	12.250	12.750		311.15	323.85	
V	6.437	6.562		163.50	166.67	
W	3.187	3.313		80.95	84.15	
X			0.562			14.27
Y			0.312			7.92

NOTES:
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

4CW100,000D

TECHNICAL DATA

LIQUID COOLED
POWER TETRODE

The EIMAC 4CW100,000D is a ceramic/metal, liquid-cooled power tetrode intended for use at the 100 to 200 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB, rf linear amplifier or a Class-AB, push-pull af amplifier or modulator. The 4CW100,000D is also useful as a plate and screen modulated Class-C rf amplifier, and in pulse modulator-regulator service.

The liquid-cooled anode is rated at 100 kilowatts maximum plate dissipation.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0	V
Current	295	A
Amplification Factor (Grid-Screen)(average)	4.5	
Interelectrode Capacitances, Grounded Cathode:[2]		
Cin	440	pF
Cout	55	pF
Cgp	2.4	pF
Interelectrode Capacitances, Grounded Grid:[2]		
Cin	175	pF
Cout	57	pF
Cpk	0.5	pF
Frequency for Maximum Ratings	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, graduated rings
Maximum Seal Temperature	250°C
Maximum Envelope Temperature	250°C
Recommended Socket	EIMAC SK-1500 Series
Operating Position	Vertical, base up or down

Maximum Dimensions:

Height	18.0 In.; 457.2 mm
Diameter	8.0 In.; 203.2 mm
Cooling	Liquid and forced air
Net Weight (Approximate)	60 lbs; 27.3 kg
Shipping Weight (Approximate)	85 lbs; 38.6 kg

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class-C Telegraphy or FM
(Key-down conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Calculated low frequency drive power.

TYPICAL OPERATION (Frequencies below 30 MHz)

Plate Voltage	15.0	17.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-700	-700	-700	Vdc
Plate Current	9.0	9.8	10.6	Adc
Screen Current	1.6	1.67	1.83	Adc
Grid Current	0.8	1.0	1.12	Adc
Peak RF Grid Voltage	1000	1020	1040	v
Driving Power [1]	790	1020	1165	W
Plate Dissipation	24.0	30.0	35	kW
Plate Output Power	110	137.5	165	kW
Resonant Load Impedance	825	845	980	Ω

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER-GRID DRIVEN
Class-C Telephony
(Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION [1]	66,500	WATTS
SCREEN DISSIPATION [4]	1750	WATTS
GRID DISSIPATION [4]	500	WATTS

1. Corresponds to 100,000 watts at 100% sine wave modulation.
2. Approximate value, depends on degree of driver modulation.

TYPICAL OPERATION (Frequencies below 30 MHz)

Plate Voltage	14	16	kVdc
Screen Voltage	750	750	Vdc
Peak AF Screen Voltage (For 100% modulation) [2]	750	750	v
Grid Voltage	-700	-700	Vdc
Plate Current	9.1	12.0	Adc
Screen Current	2.0	1.75	Adc
Grid Current	1.0	1.20	Adc
Peak RF Grid Voltage	1000	1050	v
Grid Driving Power [3]	1000	1260	W
Plate Dissipation	20.4	54.0	kW
Plate Output Power	107	138.5	kW
Resonant Load Impedance	790	620	Ω

3. Calculated low frequency drive power.
4. Average, with or without modulation.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR
Class-AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Per Tube.
2. Approximate value.

TYPICAL OPERATION (Two Tubes) Class-AB_1

Plate Voltage	15	18	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-360	-380	Vdc
Max-Signal Plate Current	18.8	20.0	Adc
Zero-Signal Plate Current	6.0	6.0	Adc
Max-Signal Screen Current [2]	0.690	0.700	Adc
Peak AF Driving Voltage [1]	350	380	v
Driving Power	0	0	W
Load Resistance, Plate-to-Plate	1800	2080	Ω
Max-Signal Plate Dissipation [1]	47.3	56.8	kW
Max-Signal Plate Output Power	187.4	246.4	kW

RADIO-FREQUENCY LINEAR AMPLIFIER
Class-AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions, (Frequencies below 30 MHz)
Class-AB

Plate Voltage	15	18	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-360	-380	Vdc
Max-Signal Plate Current	9.4	10.0	Adc
Zero-Signal Plate Current	3.0	3.0	Adc
Max-Signal Screen Current[1]	0.345	0.350	Adc
Peak RF Grid Voltage	350	380	v
Driving Power	0	0	W
Plate Dissipation	47.3	56.8	kW
Plate Output Power	93.7	123.2	kW
Resonant Load Impedance	900	1040	Ω

PULSE MODULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	40	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	- 2.0	KILOVOLTS
PEAK CATHODE CURRENT	200	AMPERES
PLATE DISSIPATION(average)	100	KILOWATTS
SCREEN DISSIPATION (average)	1750	WATTS
GRID DISSIPATION (average)	500	WATTS

1. Approximate value.

Note: The power dissipated during rise and fall time is considered negligible.

TYPICAL OPERATION

Plate Voltage	38	kVdc
Pulse Plate Current	112	a
Screen Voltage	1.5	kVdc
Pulse Screen Current[1]	18.0	a
Grid Voltage	-1.2	kVdc
Pulse Grid Current[1]	10.0	a
Pulse Positive Grid Voltage	480	v
Duty	5	%
Pulse Output Voltage	32	kv
Pulse Input Power	4.25	Mw
Pulse Output Power	3.58	Mw
Pulse Cathode Current	140	a

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection)[2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CW100,000D must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500 and SK-1510 are recommended for use with the 4CW100,000D.

COOLING - Anode cooling is accomplished by circulating water through the integral anode water jacket. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation * (kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
50	10	10
75	15	25
100	20	40

* Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 80 PSI.

A major factor effecting long life of water cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 K ohms/cm^3, and preferably above 250 K ohms/cm^3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 cfm of air directed through the center of the socket is sufficient for this purpose.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CW100,000D is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW100,000D by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW100,000D. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of the tube, and SK-1500 socket, must not exceed 100 volts.

CONTROL-GRID OPERATION - The 4CW100,000D control grid is rated at 500 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1750 watts.

Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on RMS screen voltage, and RMS screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

PLATE DISSIPATION - The plate dissipation of 100 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW100,000D is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 66,500 watts.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

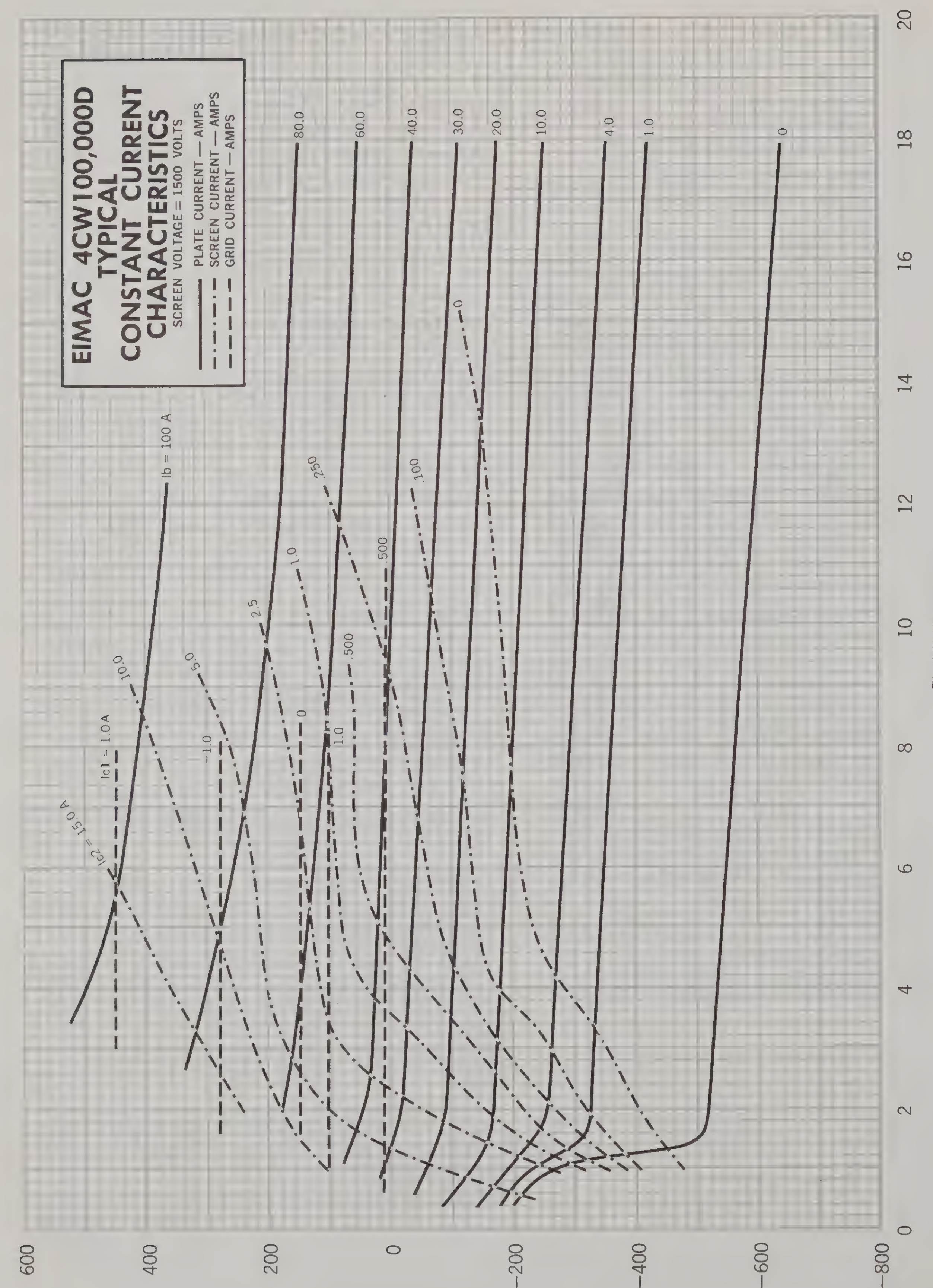
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

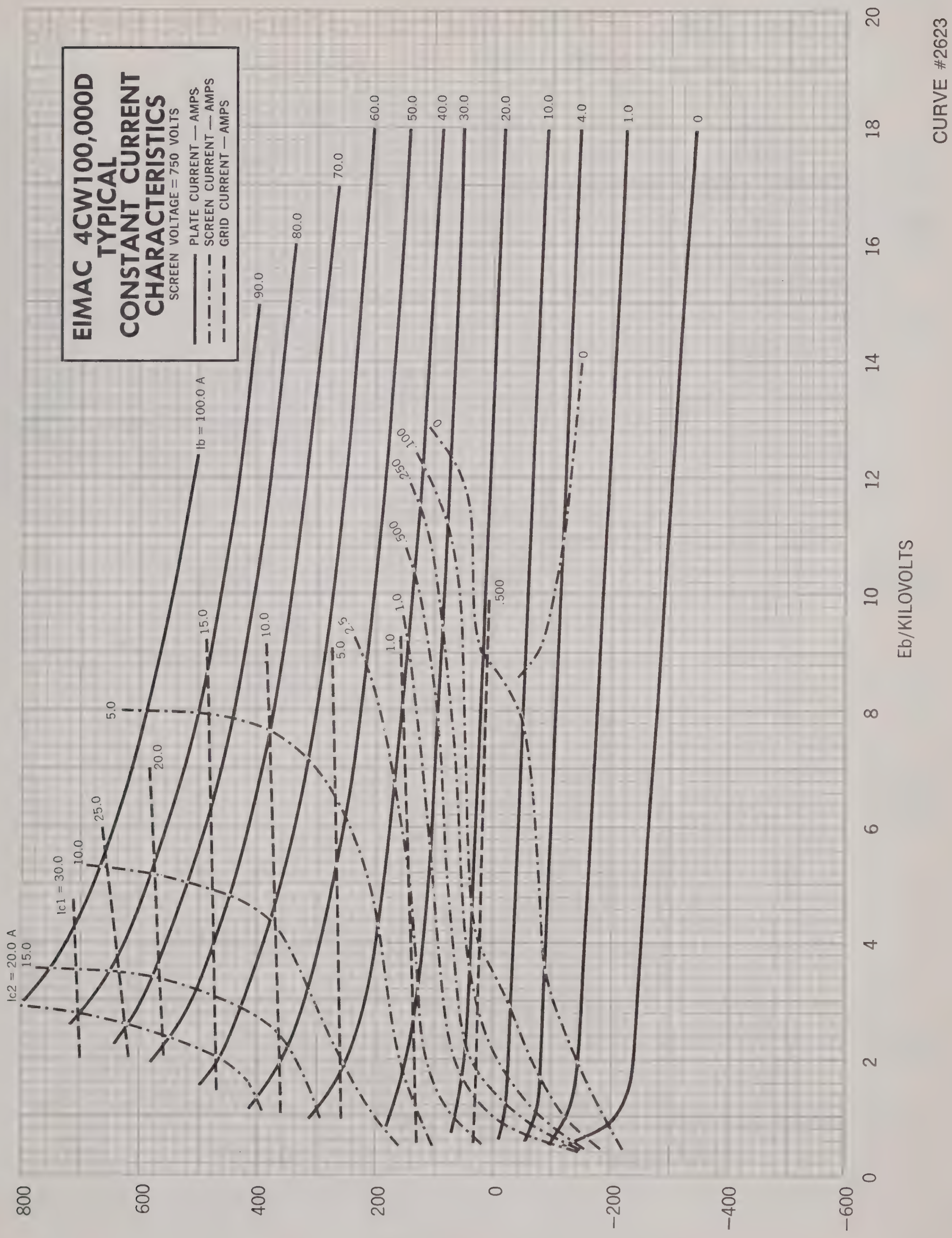
FAULT PROTECTION - In addition to normal plate overcurrent interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

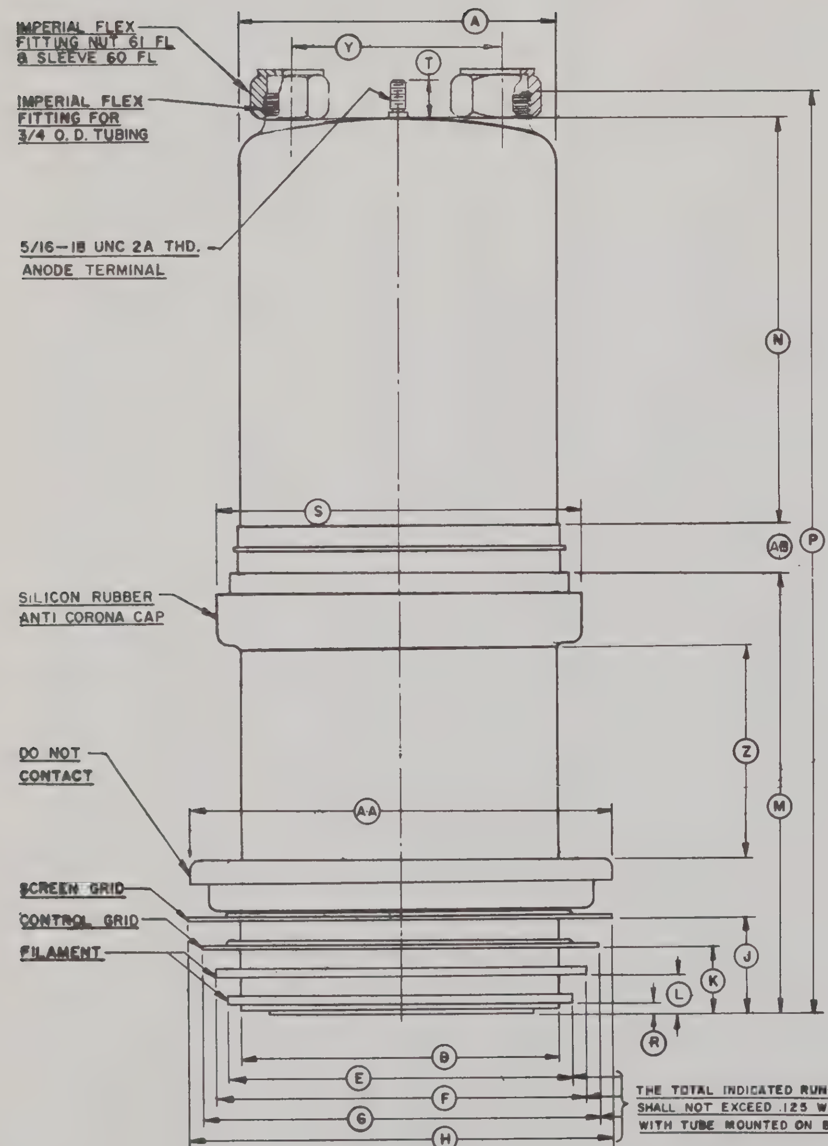
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 4CW100,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100 A
80.0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
Ic2 = 15.0 A
10.0
5.0
2.5
1.0
.500
.250
.100
0
Ic1 = 1.0 A
-1.0
0
1.0
.500
Eb/KILOVOLTS
Ec1/VOLTS
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20

CURVE #2621

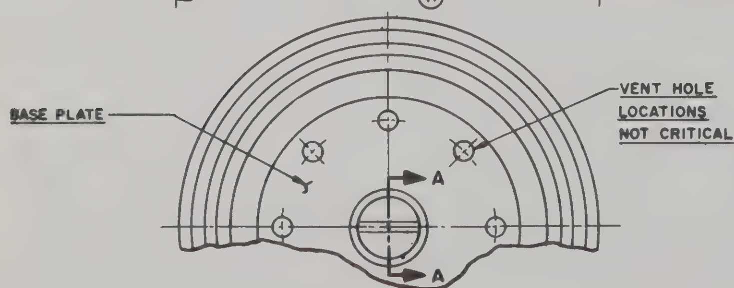

EIMAC 4CW100,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100.0 A
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
4.0
1.0
0
Ic2 = 20.0 A
15.0
10.0
5.0
2.5
1.0
.500
.250
.100
0
Ic1 = 30.0
25.0
20.0
15.0
10.0
5.0
1.0
.500
Ec1/VOLTS
800
600
400
200
0
−200
−400
−600
Eb/KILOVOLTS
0
2
4
6
8
10
12
14
16
18
20
CURVE #2623

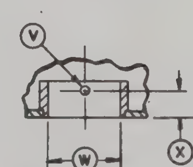
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.125	- -	149.2	155.6	- -
D	5.980	6.020	- -	151.9	152.9	- -
E	6.510	6.560	- -	165.3	166.6	- -
F	6.980	7.020	- -	177.3	178.3	- -
G	7.480	7.520	- -	190.0	191.0	- -
H	7.975	8.015	- -	202.6	203.6	- -
J	1.750	1.800	- -	44.4	45.7	- -
K	1.220	1.270	- -	31.0	32.3	- -
L	0.690	0.740	- -	17.5	18.8	- -
M	8.600	8.800	- -	218.4	223.5	- -
N	7.000	7.500	- -	177.8	190.5	- -
P	17.250	18.000	- -	438.1	457.2	- -
R	0.173	0.213	- -	4.39	5.41	- -
S	- -	- -	6.950	- -	- -	176.5
T	- -	- -	0.718	- -	- -	18.2
V	- -	0.135	- -	- -	3.43	- -
W	1.250	1.270	- -	31.7	32.2	- -
X	0.490	0.530	- -	12.4	13.5	- -
Y	3.940	4.060	- -	100.1	103.1	- -
Z	- -	- -	4.200	- -	- -	106.7
AA	- -	- -	8.000	- -	- -	203.2
AB	- -	- -	1.080	- -	- -	27.4



THE TOTAL INDICATED RUNOUT OF THESE CONTACT EDGES SHALL NOT EXCEED .125 WITH RESPECT TO "W" MEASURED WITH TUBE MOUNTED ON BOTTOM CERAMIC

NOTES:
1. THE LATERAL AXES OF THE WATER FITTINGS & BASE LOCKING PIN ARE TO BE WITHIN 10°
2. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.





SECTION A-A
ROTATED 180°

TECHNICAL DATA

8169
4CX3000A

RADIAL-BEAM POWER TETRODE

The EIMAC 8169/4CX3000A is a ceramic/metal power tetrode designed to be used as a Class AB_1 linear amplifier in audio or radio-frequency applications. Its low intermodulation distortion characteristics make it especially suitable for single-sideband service, where it will produce a minimum power output of 5000 watts in Class AB_1 service with intermodulation distortion at least 32 dB down for 3rd order products and 37 dB down for 5th order products.

The tube is also recommended for use as a Class C rf power amplifier and plate-modulated rf power amplifier. It is forced-air cooled, with a maximum anode dissipation rating of 3500 watts.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	9.0 ± 0.45	V
Current (at 9.0 volts)	41.5	A
Amplification Factor (grid to screen)	5.5	
Frequency for Maximum Ratings (CW)	150	MHz
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	130	pF
Cout	12.5	pF
Cgp	1.2	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Cin	61	pF
Cout	12.5	pF
Cpk	0.15	pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base . . . . Special ring and breechblock terminal surfaces

(Revised 1-20-76) Printed in U.S.A.

Maximum Operating Temperature:	
Ceramic/Metal Seals and Anode Core	250°C
Recommended Air System Socket	EIMAC SK-1400 series
Recommended Air Chimney	EIMAC SK-1406
Operating Position	Axis vertical, base up or down
Maximum Overall Dimensions:	
Length	7.90 In; 20.07 cm
Diameter	4.62 In; 11.73 cm
Cooling	Forced Air
Net Weight	5.5 lb; 2.5 kg

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM
(Key-down conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	3000	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

TYPICAL OPERATION

Plate Voltage	5000	7000	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-280	-300	Vdc
Plate Current	1.9	1.9	Adc
Screen Current [1]	250	230	mAdc
Grid Current [1]	100	100	mAdc
Peak RF Grid Voltage [1]	385	405	v
Driving Power [1]	39	41	W
Plate Dissipation	1900	2300	W
Plate Output Power	7600	11,000	W

1. Approximate value.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier Conditions unless noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	1.4	AMPERES
PLATE DISSIPATION [2]	2000	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

1. Approximate value.
2. Corresponds to 3000 watts at 100 % sine-wave mod.

TYPICAL OPERATION

Plate Voltage	5000	Vdc
Screen Voltage	500	Vdc
Peak AF Screen Voltage (For 100% Modulation) [1]	415	v
Grid Voltage	-375	Vdc
Plate Current	1.4	Adc
Screen Current [1]	170	mAdc
Grid Current [1]	68	mAdc
Peak RF Grid Voltage [1]	455	v
Grid Driving Power [1]	31	W
Plate Dissipation	1250	W
Plate Output Power	5750	W

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	6000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	3500	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

1. Per Tube.
2. Approximate values.

TYPICAL OPERATION (Two Tubes), Class AB_1

Plate Voltage	5000	6000	Vdc
Screen Voltage	850	850	Vdc
Grid Voltage [1]	-180	-200	Vdc
Max-Signal Plate Current	3.6	3.1	Adc
Zero-Signal Plate Current	1.0	0.7	Adc
Max-Signal Screen Current [2]	170	120	mAdc
Zero-Signal Screen Current [2]	0	0	mAdc
Peak AF Driving Voltage [1,2]	155	175	v
Driving Power	0	0	W
Load Resistance, Plate-to-Plate	3000	4160	Ω
Max-Signal Plate Dissipation [1]	3300	3100	W
Max-Signal Plate Output Power	11,400	12,400	W

RADIO-FREQUENCY LINEAR AMPLIFIER
Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	3500	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

1. Approximate values.

TYPICAL OPERATION Class AB_1, Grid Driven

Plate Voltage	5000	Vdc
Screen Voltage	850	Vdc
Grid Voltage	-180	Vdc
Zero-Signal Plate Current	0.5	Adc
Single-Tone Plate Current	1.65	Adc
Single-Tone Screen Current [1]	25	mAdc
Two-Tone Plate Current [1]	1.10	Adc
Two-Tone Screen Current [1]	20	mAdc
Peak RF Grid Voltage [1]	155	v
Driving Power	0	W
Peak Envelope Useful Output Power [1]	5300	W
Intermodulation Distortion Products (without negative feedback) 3rd Order	-35	dB
5th Order	-40	dB

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current, at 9:0 volts	39.5	43.5	A
Interelectrode Capacitance (grounded cathode) [1]			
Cin	120	140	pF
Cout	10.5	14.5	pF
Cgp	---	1.40	pF
Interelectrode Capacitance (grounded grid) [1]			
Cin	55.0	67.0	pF
Cout	10.5	14.5	pF
Cpk	---	0.20	pF
Grid Voltage (E_b = 2000 Vdc; E_{c2} = 750 Vdc; adjust for I_b = 1000 mAdc)	-95	-127	Vdc
Grid Cut off Voltage (E_b = 4000 Vdc; E_{c2} = 850 Vdc; adjust for I_b = 1.0 mAdc)	---	-310	Vdc

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX3000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKETING - The EIMAC sockets, type SK-1400A and SK-1470A, have been designed especially for the base of the 4CX3000A. The SK-1400A has no contacts grounded to the socket shell and has an integral screen grid bypass capacitor of 1800 pF, with a 1000 DCWV rating.

The SK-1470A has no bypass capacitor and the screen grid contacts are directly grounded to the socket shell.

The use of recommended air-flow rates through these sockets provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals through the Air Chimney SK-1406, and through the anode cooling fins.

COOLING - The maximum temperature rating for the external surfaces of the 4CX3000A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperature at 200°C in 40°C ambient air are tabulated below (for operation below 30 megahertz).

Plate Dissipation* (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (In. of Water)	Air Flow (CFM)	Pressure Drop (In. of Water)
1500	36.5	0.3	53	0.4
2500	60	0.8	88	1.2
3500	86	1.6	125	2.3

* Since the power dissipated by the filament represents about 450 watts and since grid-plus-screen dissipation can, under some conditions, represent another 225 watts, allowance has been made in preparing this tabulation for an additional 675 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CX3000A is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CX3000A by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CX3000A. At some point in filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appears to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

GRID OPERATION - The 4CX3000A grid has a maximum dissipation rating of 50 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX3000A must not exceed 175 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 175 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX3000A is 3500 watts. When it is operated as a plate-modulated rf amplifier, under carrier conditions, the maximum plate dissipation is 2000 watts.

FAULT PROTECTION - In addition to normal cooling airflow interlock and plate and screen over-current interlocks, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

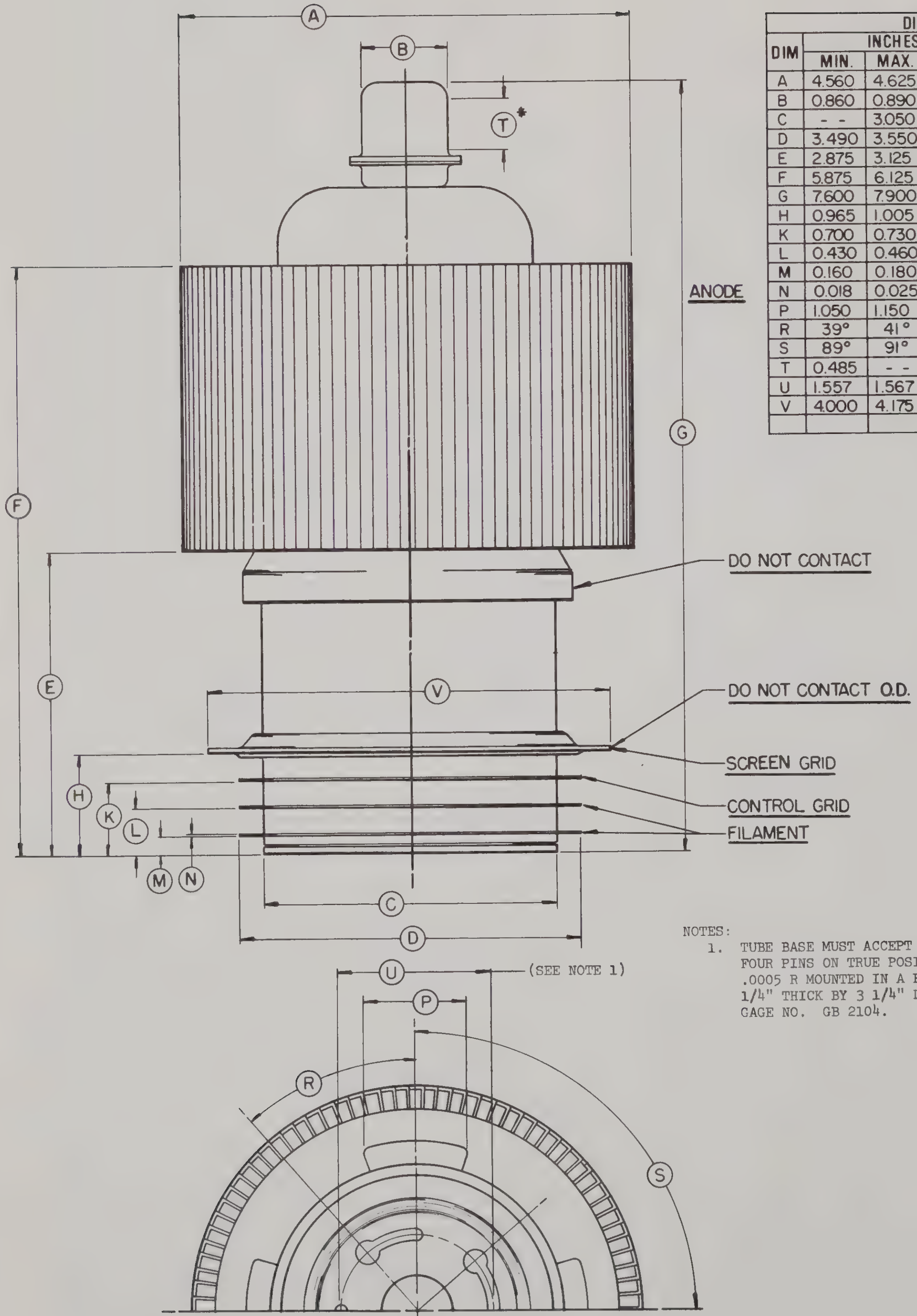
In all cases some protective resistance, at least one or two ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. Where stored energy is high, it is recommended that some form of electronic crowbar be used which will discharge power supply capacitors in as short a time as possible following indication of start of a plate arc.

HIGH VOLTAGE - Normal operating voltages used with the 4CX3000A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

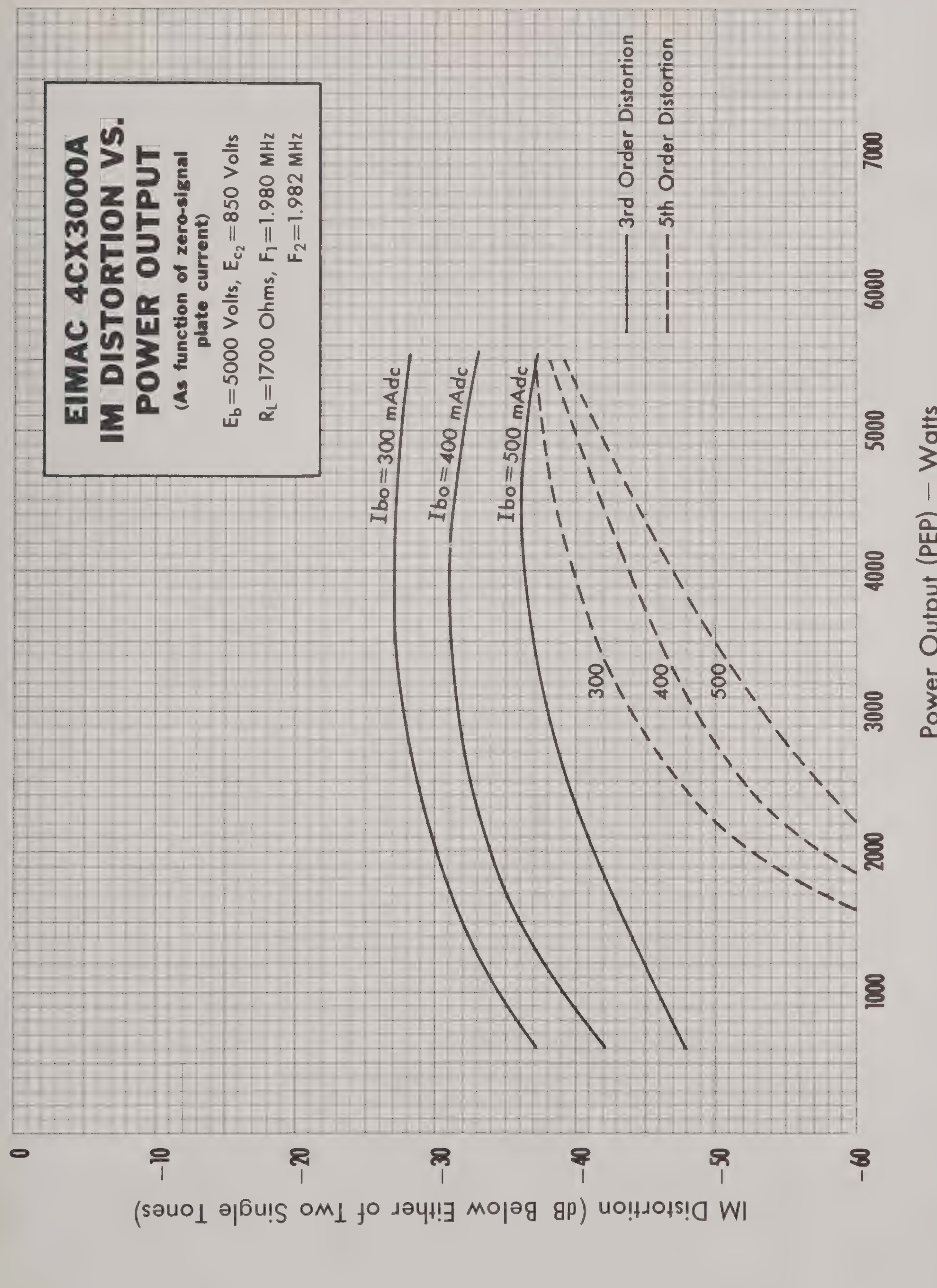


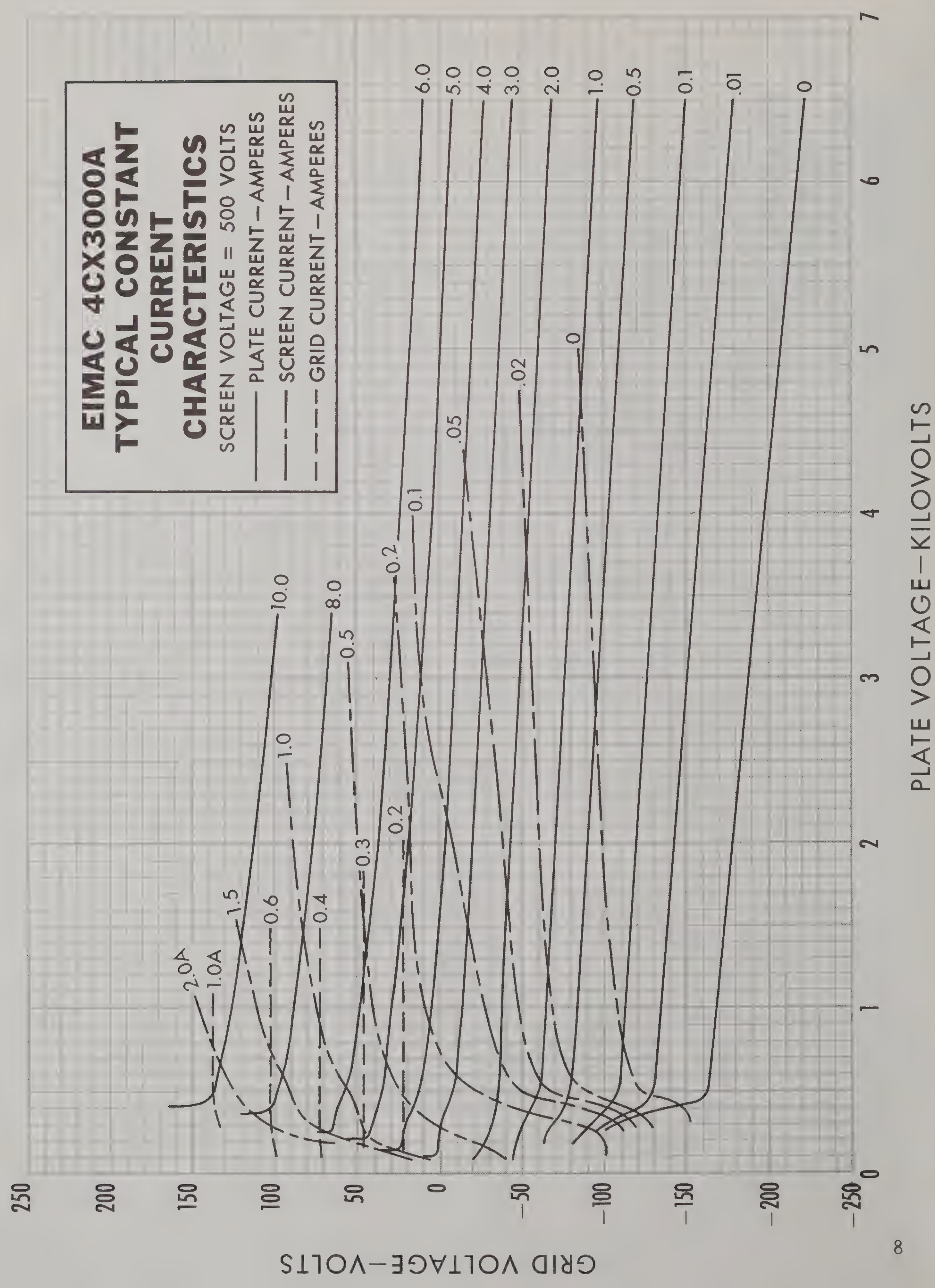
DIM	INCHES MIN.	INCHES MAX.	INCHES REF.	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF.
A	4.560	4.625	- -	115.82	117.48	- -
B	0.860	0.890	- -	21.84	22.61	- -
C	- -	3.050	- -	- -	77.44	- -
D	3.490	3.550	- -	88.65	90.17	- -
E	2.875	3.125	- -	73.03	79.38	- -
F	5.875	6.125	- -	149.23	155.58	- -
G	7.600	7.900	- -	193.04	200.66	- -
H	0.965	1.005	- -	24.51	25.53	- -
K	0.700	0.730	- -	17.78	18.54	- -
L	0.430	0.460	- -	10.92	11.68	- -
M	0.160	0.180	- -	4.06	4.57	- -
N	0.018	0.025	- -	0.46	0.64	- -
P	1.050	1.150	- -	26.67	29.21	- -
R	39°	41°	- -	39°	41°	- -
S	89°	91°	- -	89°	91°	- -
T	0.485	- -	- -	12.32	- -	- -
U	1.557	1.567	- -	39.55	39.80	- -
V	4.000	4.175	- -	101.60	106.05	- -

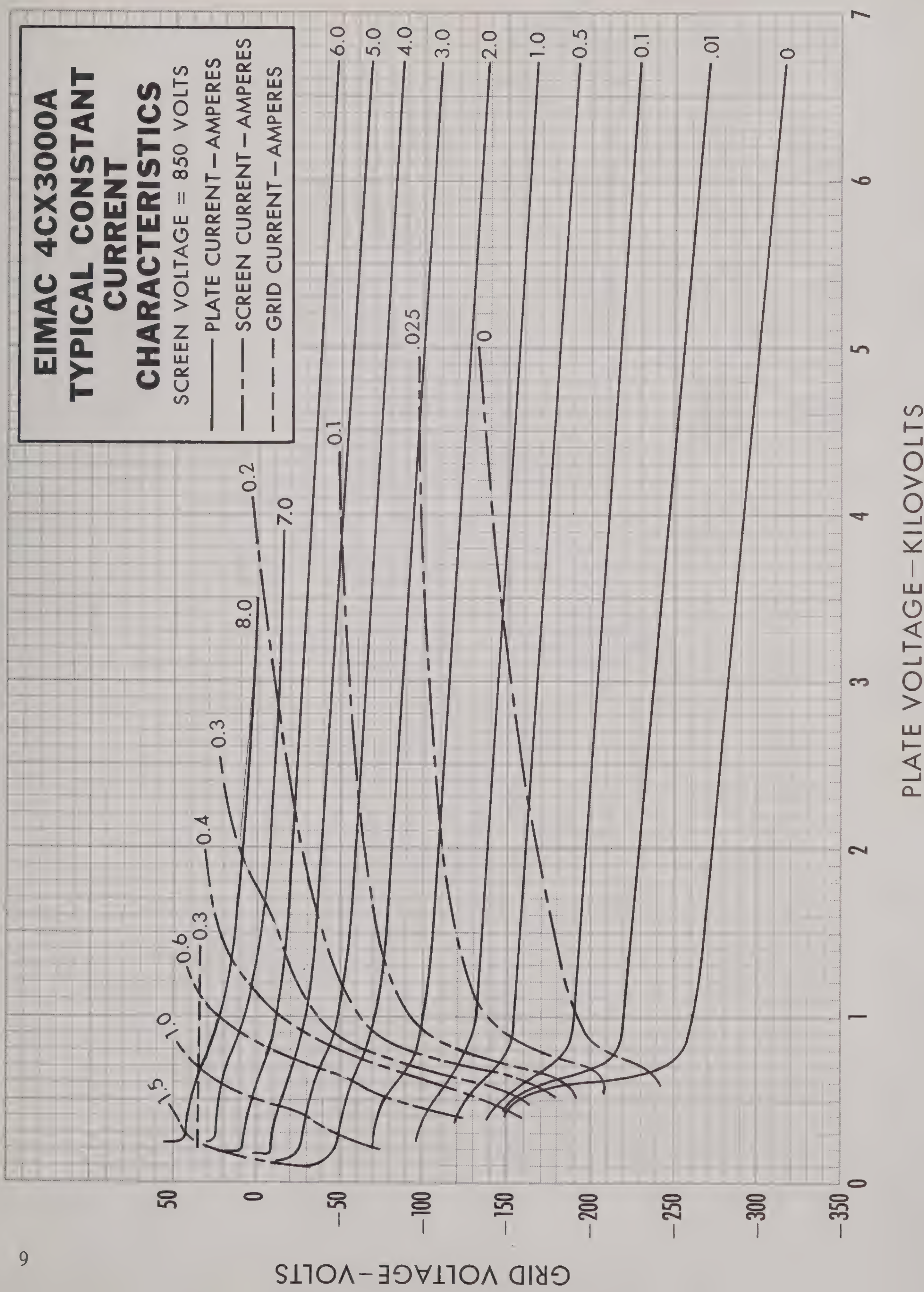
Table title: DIMENSIONAL DATA

NOTES:

1. TUBE BASE MUST ACCEPT A GAGE WITH FOUR PINS ON TRUE POSITION WITHIN .0005 R MOUNTED IN A BASE PLATE 1/4" THICK BY 3 1/4" DIA. EIMAC GAGE NO. GB 2104.


EIMAC 4CX3000A
IM DISTORTION VS.
POWER OUTPUT
(As function of zero-signal plate current)
E_b=5000 Volts, E_{c_2}=850 Volts
R_L=1700 Ohms, F_1=1.980 MHz
F_2=1.982 MHz
I_{bo}=300 mAdc
I_{bo}=400 mAdc
I_{bo}=500 mAdc
300
400
500
3rd Order Distortion
5th Order Distortion
0
−10
−20
−30
−40
−50
−60
IM Distortion (dB Below Either of Two Single Tones)
1000
2000
3000
4000
5000
6000
7000
Power Output (PEP) — Watts


EIMAC 4CX3000A
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE—VOLTS
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.1
.01
0
10.0
8.0
1.5
2.0A
1.0A
0.6
0.4
0.3
0.2
0.5
1.0
0.2
0.1
.05
.02
0
250
200
150
100
50
0
−50
−100
−150
−200
−250
0
1
2
3
4
5
6
7


EIMAC 4CX3000A
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 850 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE—VOLTS
0
1
2
3
4
5
6
7
50
0
−50
−100
−150
−200
−250
−300
−350
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.1
.01
0
7.0
8.0
0.2
0.1
.025
0
0.3
0.4
0.3
0.6
1.0
1.5

TECHNICAL DATA

8349 / 4CX35,000C

RADIAL-BEAM POWER TETRODE

The EIMAC 8349/4CX35,000C is a ceramic/metal, forced-air cooled power tetrode intended for use at the 50 to 150 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB rf linear amplifier, or a Class-AB push-pull af amplifier or modulator. The 8349/4CX35,000C is also useful as a plate and screen modulated Class-C rf amplifier.

The forced-air cooled anode is rated at 35 kilowatts maximum dissipation.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten
- Voltage . . . . 10.0 V
- Current, at 10.0 volts . . . . 295 A

Amplification Factor (Average):
- Grid to Screen 4.5

Direct Interelectrode Capacitances (grounded cathode)[2]
- Cin . . . . 440 pF
- Cout . . . . 55 pF
- Cgp . . . . 2.3 pF

Frequency of Maximum Rating:
- CW . . . . 30 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:
- Length . . . . 17.34 in; 440.4 mm
- Diameter . . . . 9.75 in; 247.7 mm

Net Weight . . . . 50 lb; 22.7 kg

Operating Position . . . . Vertical, base up or down

Maximum Operating Temperature:
- Ceramic/Metal Seals . . . . 250°C
- Anode Core . . . . 250°C

Cooling . . . . Forced Air

Base . . . . Special, graduated rings

Recommended Socket . . . . EIMAC SK-1500 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	15.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-400	Vdc
Zero-Signal Plate Current	1.0	Adc
Single Tone Plate Current	5.7	Adc
Single-Tone Screen Current [2]	0.9	Adc
Peak rf Grid Voltage [2]	250	v
Peak Driving Power [2]	0	w
Plate Dissipation	30	kW
Plate Output Power	55	kW
Resonant Load Impedance	1280	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-425	-480	-550	Vdc
Plate Current	7.5	6.8	6.96	Adc
Screen Current [1]	0.84	0.51	0.80	Adc
Grid Current [1]	0.29	0.23	0.35	Adc
Peak rf Grid Voltage [1]	600	660	730	v
Calculated Driving Power [1]	180	150	258	W
Plate Dissipation	19.3	19.0	21.0	kW
Plate Output Power	55.5	82.5	110	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	14,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION [1]	23,000	WATTS
SCREEN DISSIPATION [2]	1750	WATTS
GRID DISSIPATION [2]	500	WATTS

1. Corresponds to 35,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	12.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-600	Vdc
Plate Current	5.4	Adc
Screen Current [1]	0.52	Adc
Grid Current [1]	0.16	Adc
Peak af Screen Voltage [2] (100% modulation)	500	v
Peak rf Grid Voltage [1]	740	v
Calculated Driving Power	125	W
Plate Dissipation	13.2	kW
Plate Output Power	55.0	kW
Resonant Load Impedance	1120	Ω

1. Approximate value.

2. Approximate value, depending upon degree of driver modulation.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
Class AB, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	12.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage[1/3]	-400	Vdc
Zero-Signal Plate Current	3.0	Adc
Max Signal Plate Current	9.2	Adc
Max Signal Screen Current[1]	1.8	Adc
Peak af Grid Voltage[2]	280	v
Max Signal Plate Dissipation[2]	20	kW
Plate Output Power	70	kW
Load Resistance (plate to plate)	2860	Ω

2. Per Tube
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection)[2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000C must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500, and SK-1510 have been designed especially for the concentric base terminals of the 4CX35,000C.

COOLING - The maximum temperature rating for the external surfaces of the 4CX35,000C is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain core temperature at 225°C in 40° ambient air are tabulated below (for operation below 30 megahertz.) These data are for air flowing in the base-to-anode direction.

	Base-to-Anode Air Flow			
	Sea Level		10,000 Feet	
Plate Dissipation* (Watts)	Air Flow (CFM)	Pressure Drop(Inches of Water)	Air Flow (CFM)	Pressure Drop(Inches of Water)
15,000	440	1.0	635	1.44
20,000	650	2.0	935	2.9
25,000	975	3.8	1400	5.5
30,000	1300	6.0	1870	8.6
35,000	1760	9.6	2535	13.8

* Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 CFM of air directed through the center of the socket is sufficient for this purpose.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CX35,000C is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CX35,000C by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CX35,000C. At some point in filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appears to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of tube and SK-1500 socket, must not exceed 100 volts.

GRID OPERATION - The 4CX35,000C grid has a maximum dissipation rating of 500 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX35,000C must not exceed 1750 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 1750 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX35,000C is 35,000 watts. When the 4CX35,000C is operated as a plate-modulated rf amplifier, under carrier conditions, the maximum plate dissipation is 23,000 watts.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capaci-

tance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - Normal operating voltages used with the 4CX35,000C are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

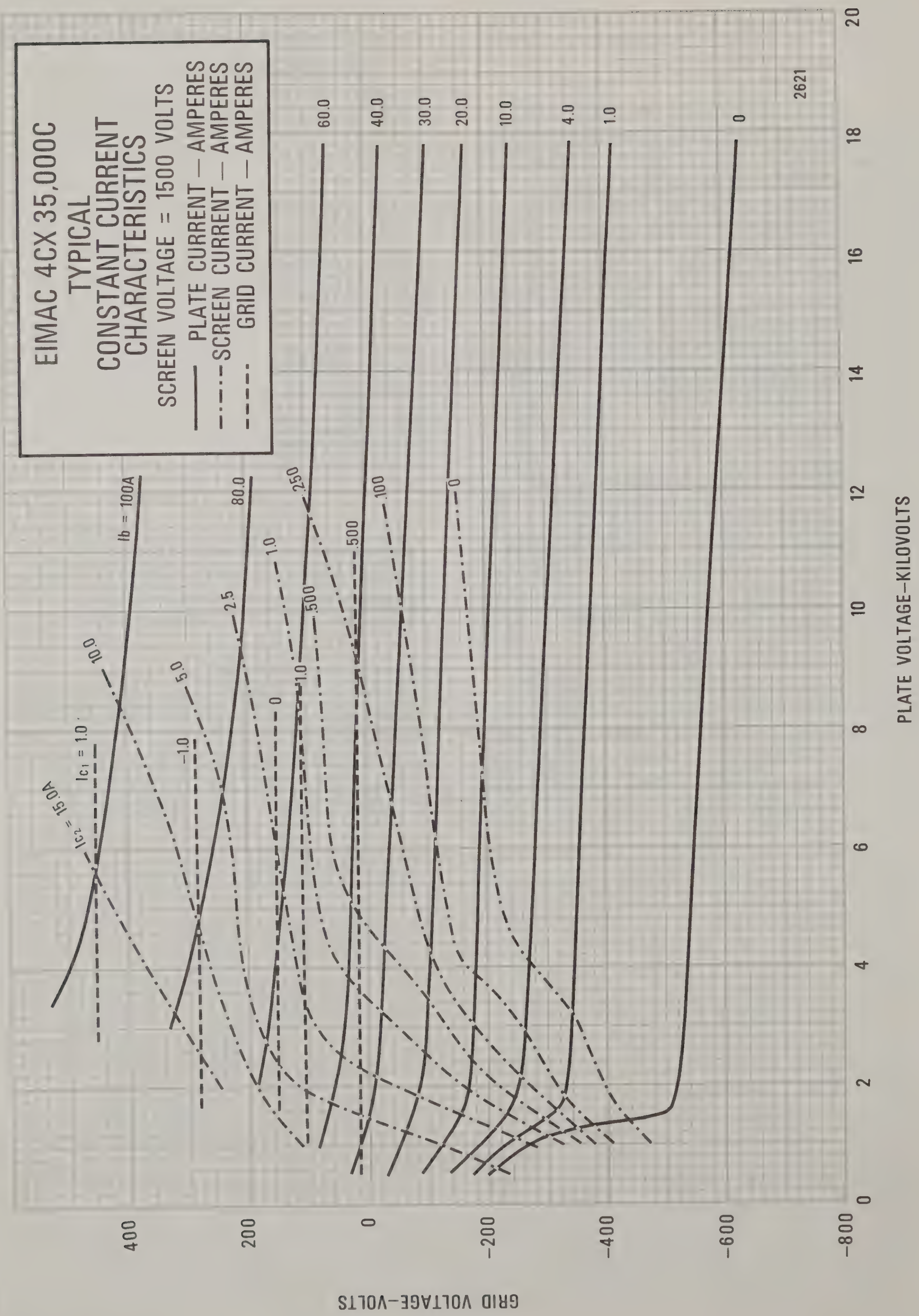
FAULT PROTECTION - In addition to normal cooling airflow interlock and plate and screen over-current interlocks, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

In all cases some protective resistance, at least one or two ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. Where stored energy is high, it is recommended that some form of electronic crowbar be used which will discharge power supply capacitors in as short a time as possible following indication of start of a plate arc.

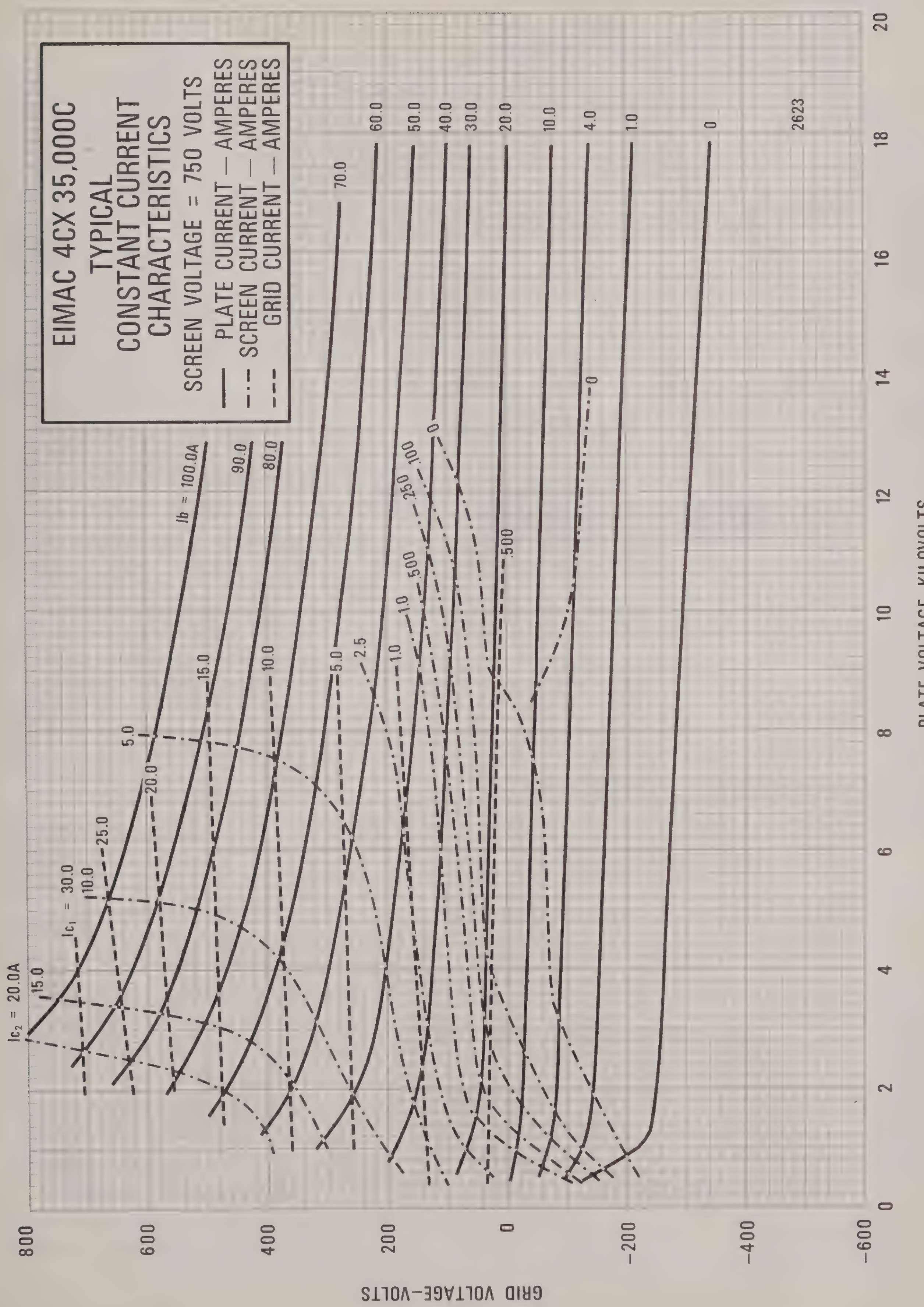
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CX35,000C, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

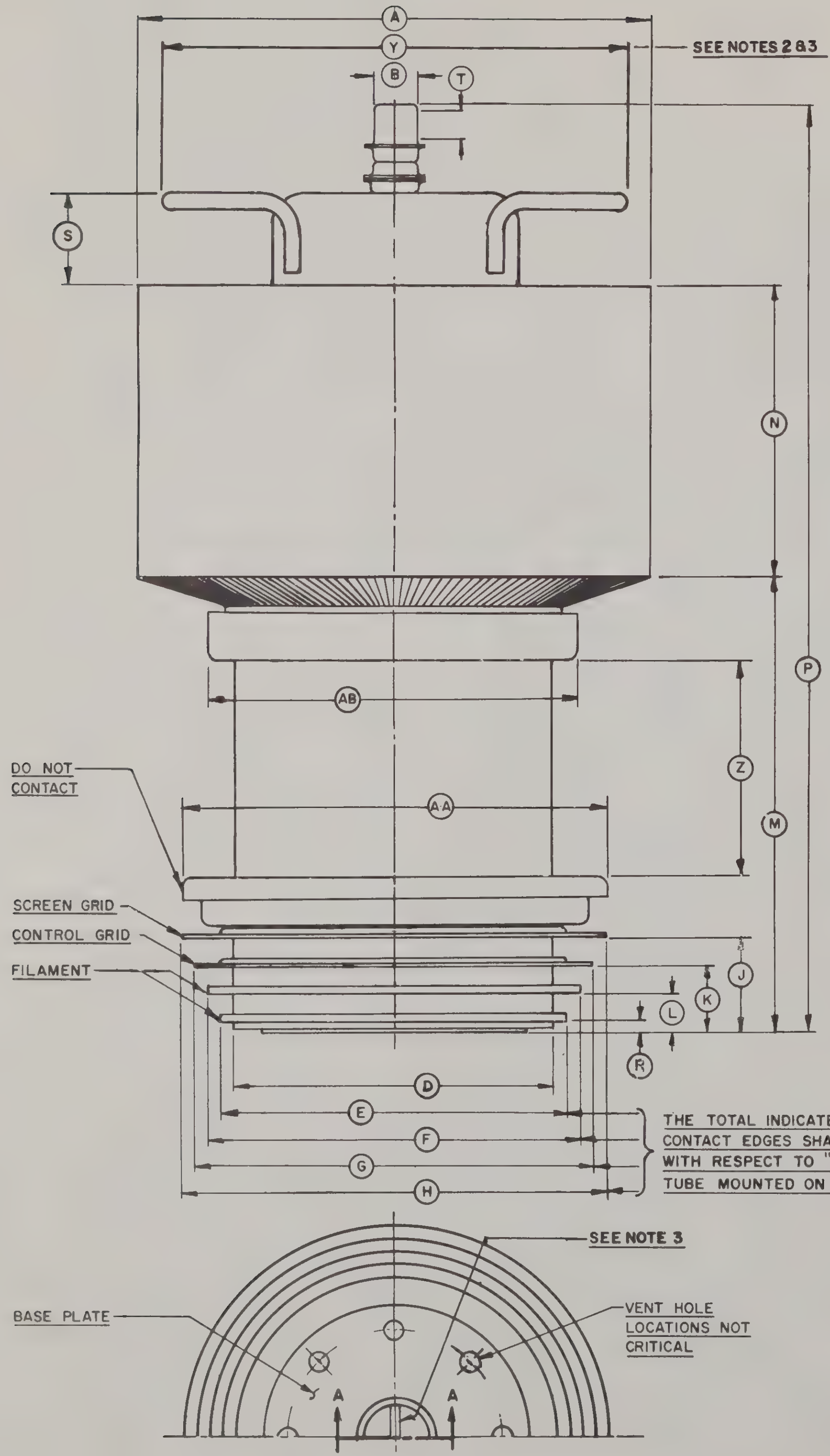
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

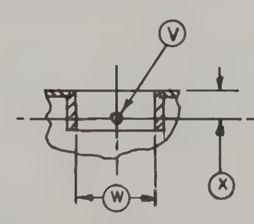

EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
Ib = 100A
80.0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
Ic2 = 15.0A
10.0
5.0
2.5
1.0
.500
.250
.100
0
-1.0
Ic1 = 1.0
0
1.0
.500
0
2621
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE—VOLTS
0
2
4
6
8
10
12
14
16
18
20
400
200
0
-200
-400
-600
-800

#2621


EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
Ib = 100.0A
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
4.0
1.0
0
Ic2 = 20.0A
15.0
Ic1 = 30.0
10.0
25.0
20.0
5.0
15.0
10.0
5.0
2.5
1.0
.500
.250
.100
2623
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE—VOLTS
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14
16
18
20

#2623





SECTION A–A

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	1.750		44.45	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	— —	8.750	— —	222.25
Z	3.750		95.25	
AA	8.000		203.20	
AB	6.875		174.63	

NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIM. Y IS MAXIMUM DIA. ACROSS CORNERS
3. HANDLE LATERAL AXIS ORIENTATION WITH BASE LOCK PIN IS AS SHOWN.

TECHNICAL DATA

RADIAL BEAM POWER PENTODE

The EIMAC 5CX1500A is a ceramic/metal power pentode designed for use as a Class AB_1 linear amplifier in audio or radio frequency applications. Its characteristic low intermodulation distortion makes it especially suitable for single sideband service. The filament is a rugged mesh type.

The tube is also recommended for use as a Class C rf power amplifier in CW, FM and AM service.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	5.0 ± 0.25 V
Current, at 5.0 volts	38.5 A

Transconductance (Average):

I_b = 1.0 Adc, E_{c2} = 500 Vdc	24,000 μmhos

Amplification Factor (Average):

Grid to Screen	5.5

Direct Interelectrode Capacitance (grounded cathode)[2]

Input	75 pF
Output	16.5 pF
Feedback	0.20 pF

Frequency of Maximum Rating:

CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:

Length	5.150 in; 130.81 mm
Diameter	3.370 in; 85.60 mm
Net Weight	30 oz; 850.5 gm
Operating Position	Axis vertical, base down or up

Maximum Operating Temperature:

Ceramic/Metal Seals	250°C
Anode Core	250°C

Cooling	Forced Air
Base	Special ring and breechblock terminal surfaces
Recommended Air System Socket	EIMAC SK-840 series
Recommended (Air) Chimney	EIMAC SK-806

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION	75	WATTS
GRID DISSIPATION	25	WATTS

1. Adjust to specified zero-signal dc plate current.
2. The intermodulation distortion products are referenced against one tone of a two equal tone signal.
3. Approximate values.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven

Plate Voltage	2500	3000	4000	Vdc
Suppressor Voltage	0	0	0	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage [1]	-87	-89	-90	Vdc
Zero-Signal Plate Current	250	250	250	mAdc
Single-Tone Plate Current	660	690	690	mAdc
Two-Tone Plate Current	470	480	485	mAdc
Single-Tone Screen Current [3]	79	71	59	mAdc
Two-Tone Screen Current [3]	36	32	25	mAdc
Peak rf Grid Voltage [3]	87	89	90	v
Peak Driving Power [3]	0	0	0	w
Single-Tone Useful Output Power	1090	1330	1785	W
Resonant Load Impedance	2340	2680	3500	Ω
Intermodulation Distortion Products [2]				
3rd Order	-38	-36	-33	db
5th Order	-39	-41	-42	db

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION	75	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	3000	4000	4500	Vdc
Suppressor Voltage	0	0	0	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-200	-200	-200	Vdc
Plate Current	900	800	900	mAdc
Screen Current [1]	94	66	88	mAdc
Grid Current [1]	35	25	34	mAdc
Peak rf Grid Voltage [1]	255	245	255	v
Calculated Driving Power	9.0	6.5	9.0	W
Plate Input Power	2700	3200	4050	W
Plate Dissipation	720	850	870	W
Plate Output Power	1980	2350	3180	W
Resonant Load Impedance	1570	2240	2520	Ω

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3500	VOLTS
DC SCREEN VOLTAGE	550	VOLTS
DC PLATE CURRENT	0.8	AMPERE
PLATE DISSIPATION [1]	1000	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION [2]	75	WATTS
GRID DISSIPATION [2]	25	WATTS

1. Corresponds to 1500 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	2500	3200	Vdc
Suppressor Voltage	0	0	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-260	-260	Vdc
Plate Current	800	800	mAdc
Screen Current [1]	90	86	mAdc
Grid Current [1]	32	32	mAdc
Peak af Screen Voltage [1] (100% modulation)	500	500	v
Peak rf Grid Voltage [1]	315	315	v
Calculated Driving Power	10	10	W
Plate Input Power	2000	2560	W
Plate Dissipation	530	576	W
Plate Output Power	1470	1958	W
Resonant Load Impedance	1360	1863	Ω

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION	75	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	2800	3800	Vdc
Suppressor Voltage	0	0	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-81	-83	Vdc
Zero-Signal Plate Current	0.50	0.50	Adc
Max. Signal Plate Current	1.30	1.33	Adc
Zero-Signal Screen Current	20	20	mAdc
Max. Signal Screen Current	110	106	mAdc
Peak af Grid Voltage	81	83	v
Peak Driving Power	0	0	w
Max. Signal Plate Dissipation	720	1130	W
Plate Output Power	2200	3220	W
Load Resistance(plate to plate)	4800	6720	Ω

1. Approximate value.
2. Per tube .
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 5.0 volts	36.5	40.5	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Input	70	80	pF
Output	14.5	18.5	pF
Feedback	---	0.25	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Input	32	37	pF
Output	14.5	18.5	pF
Feedback	---	0.05	pF

APPLICATION

MECHANICAL

MOUNTING - The 5CX1500A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-840 socket and SK-806 chimney have been designed especially for the 5CX1500A. The use of recommended airflow rates through these sockets provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals through the Air Chimney, and exits through the anode cooling fins.

COOLING - The maximum temperature rating for the anode core of the 5CX1500A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperature at 225°C in 50°C ambient air are tabulated below (for operation below 30 MHz).

	SEA LEVEL		6000 FEET	
PLATE DISSIPATION (WATTS)	AIR FLOW (CFM)	PRESSURE DROP (INCHES of WATER)	AIR FLOW (CFM)	PRESSURE DROP (INCHES of WATER)
1000	27	.33	33	.40
1500	47	.76	58	.95

* Since the power dissipated by the filament represents about 200 watts and since grid-plus-screen-plus-suppressor dissipation can, under some conditions, represent another 125 watts, allowance has been made in preparing this tabulation for an additional 325 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 5CX1500A is 5.0 volts. Filament voltage, as measured at the socket, should be maintained within ±5% of this value or below to obtain maximum tube life.

INTERMODULATION DISTORTION - The Radio Frequency Linear Amplifier operating conditions including distortion data are the results of operation in a neutralized, grid-driven amplifier. Plots of IM distortion versus power output under two-tone condition for a typical tube are shown on next page.

GRID OPERATION - The rated dissipation of the grid is 25 watts. This is approximately the product of dc grid current and peak positive grid voltage. Operation at bias and drive levels near those listed will insure safe operation.

SCREEN OPERATION - The power dissipated by the screen of the 5CX1500A must not exceed 75 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon rms screen current and voltage.

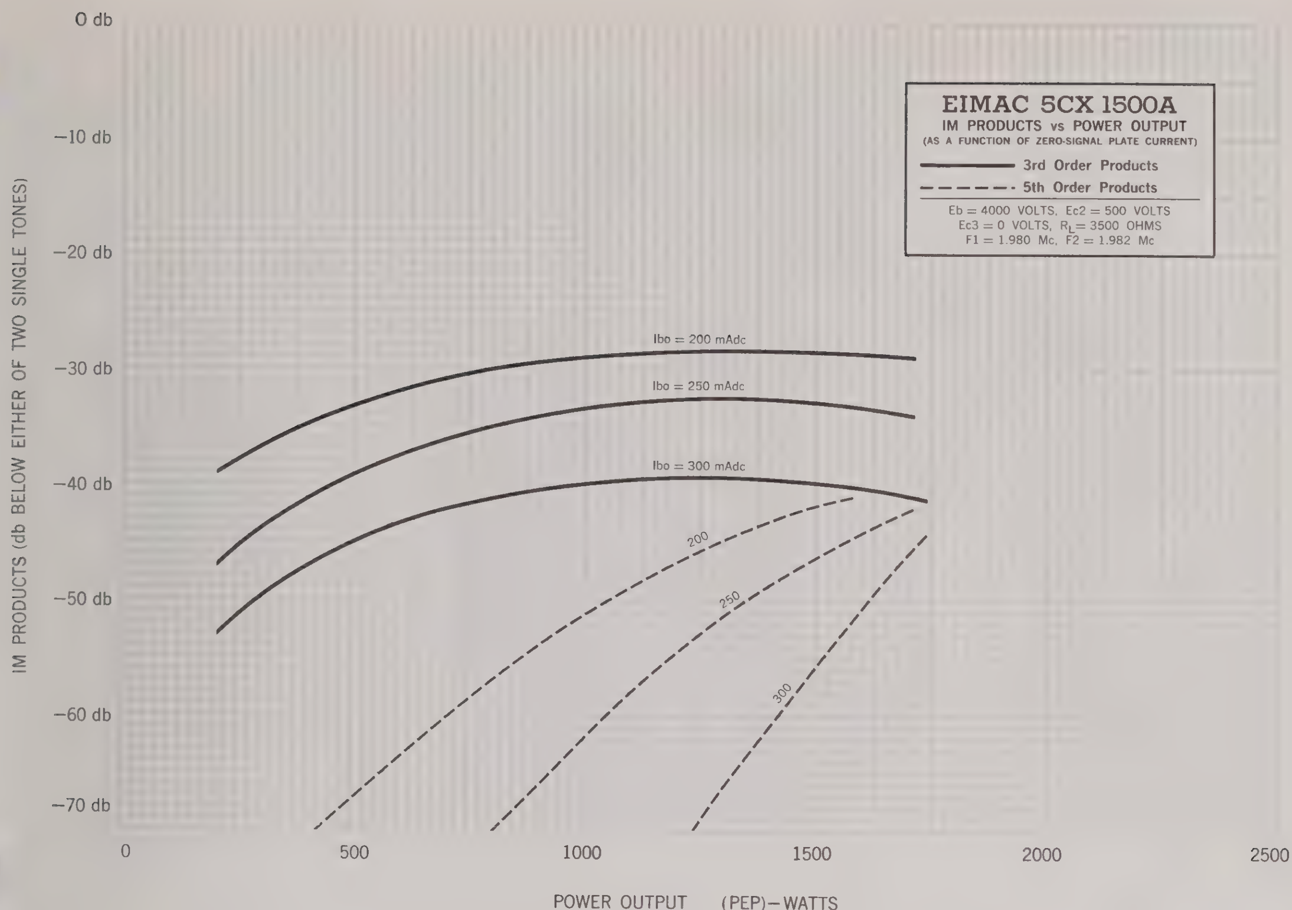
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 75 watts in the event of circuit failure.

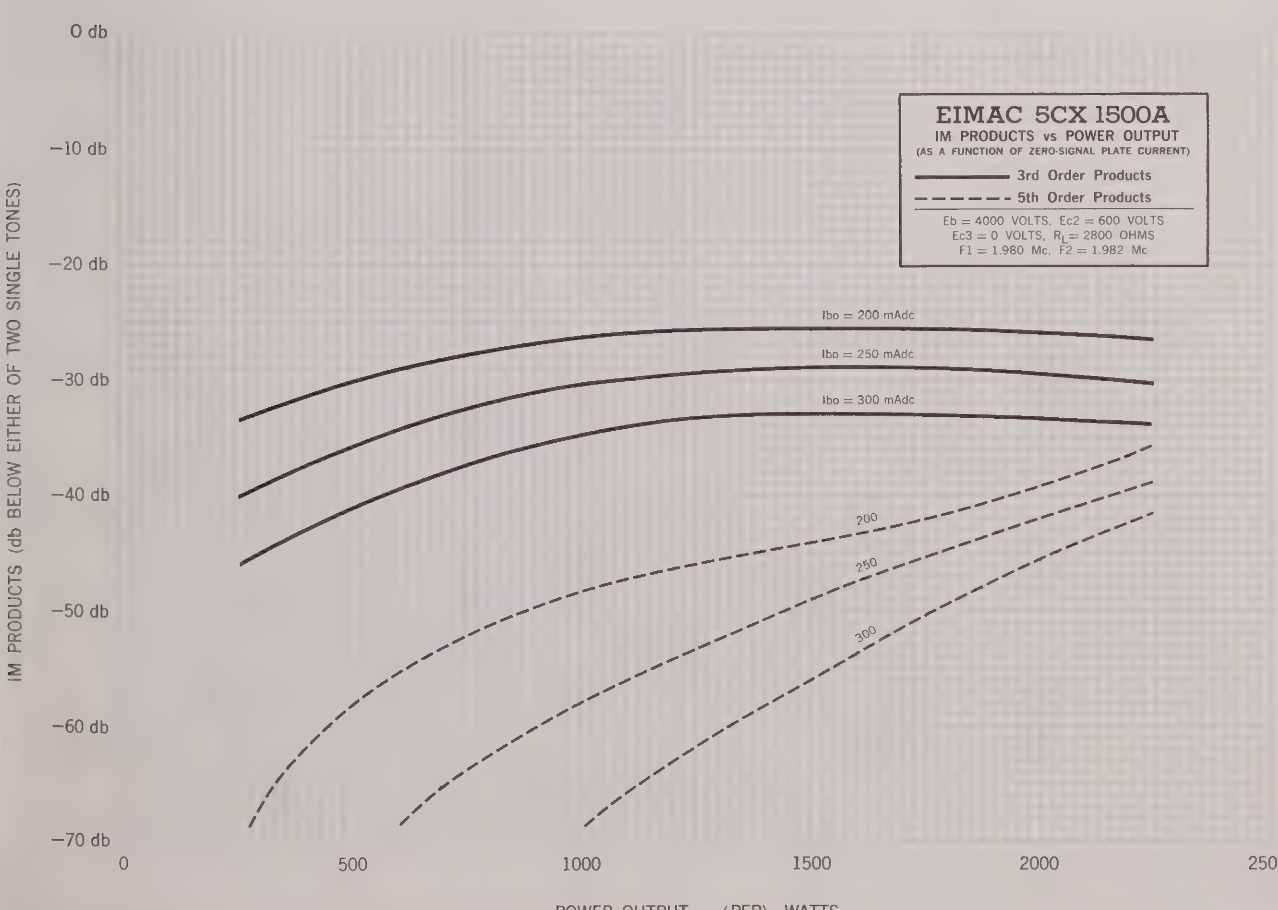
SUPPRESSOR OPERATION - The rated dissipation of the suppressor is 25 watts. Suppressor current will be zero or very nearly zero for all typical operating conditions specified. The 5CX1500A has been designed for zero voltage operation of the suppressor grid for most applications.

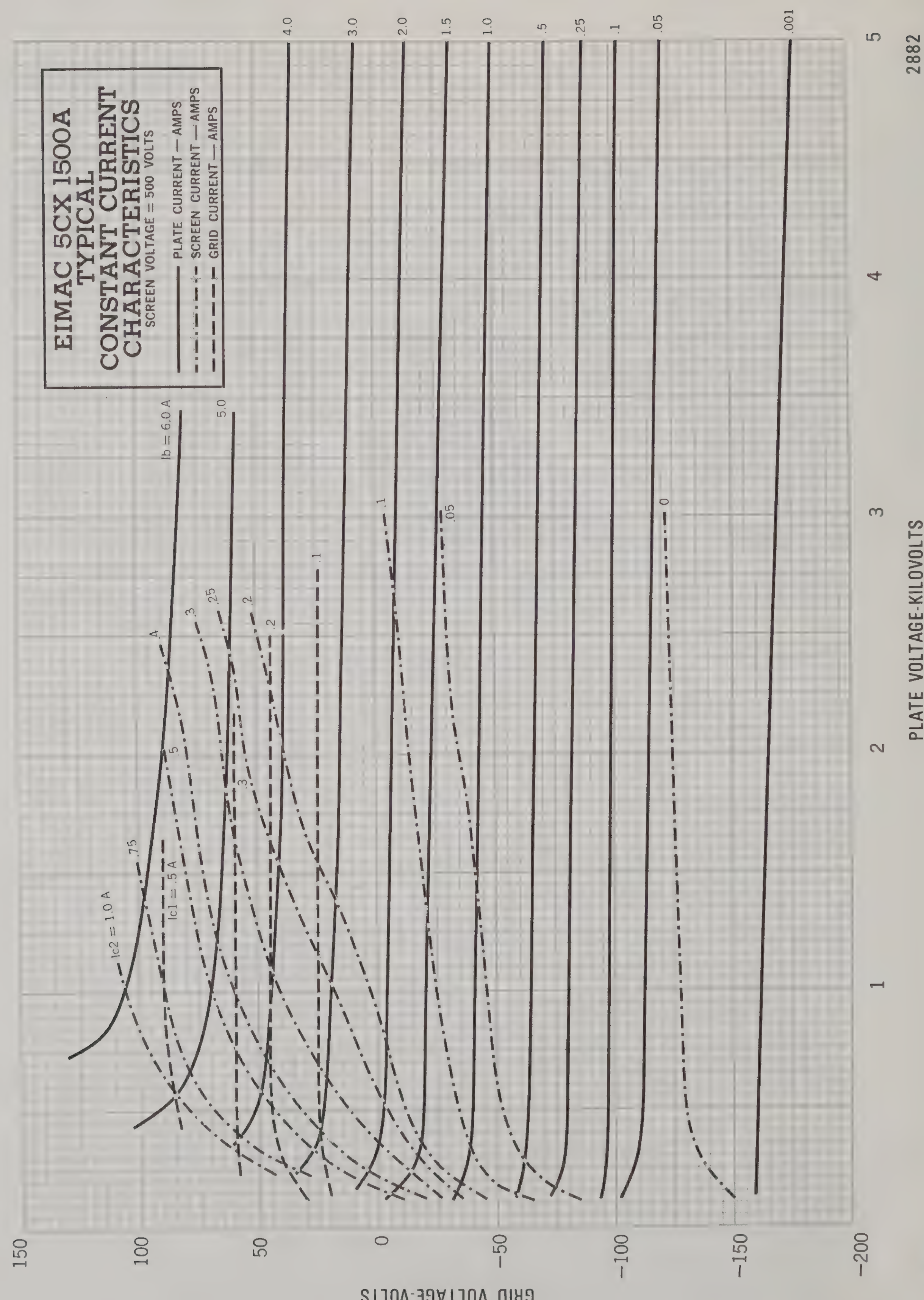
PLATE DISSIPATION - The plate-dissipation ratings for the 5CX1500A is 1000 watts for Class-C plate-modulated service and 1500 watts for Class-C telegraphy. In Class-AB service the plate dissipation rating is 1500 watts.

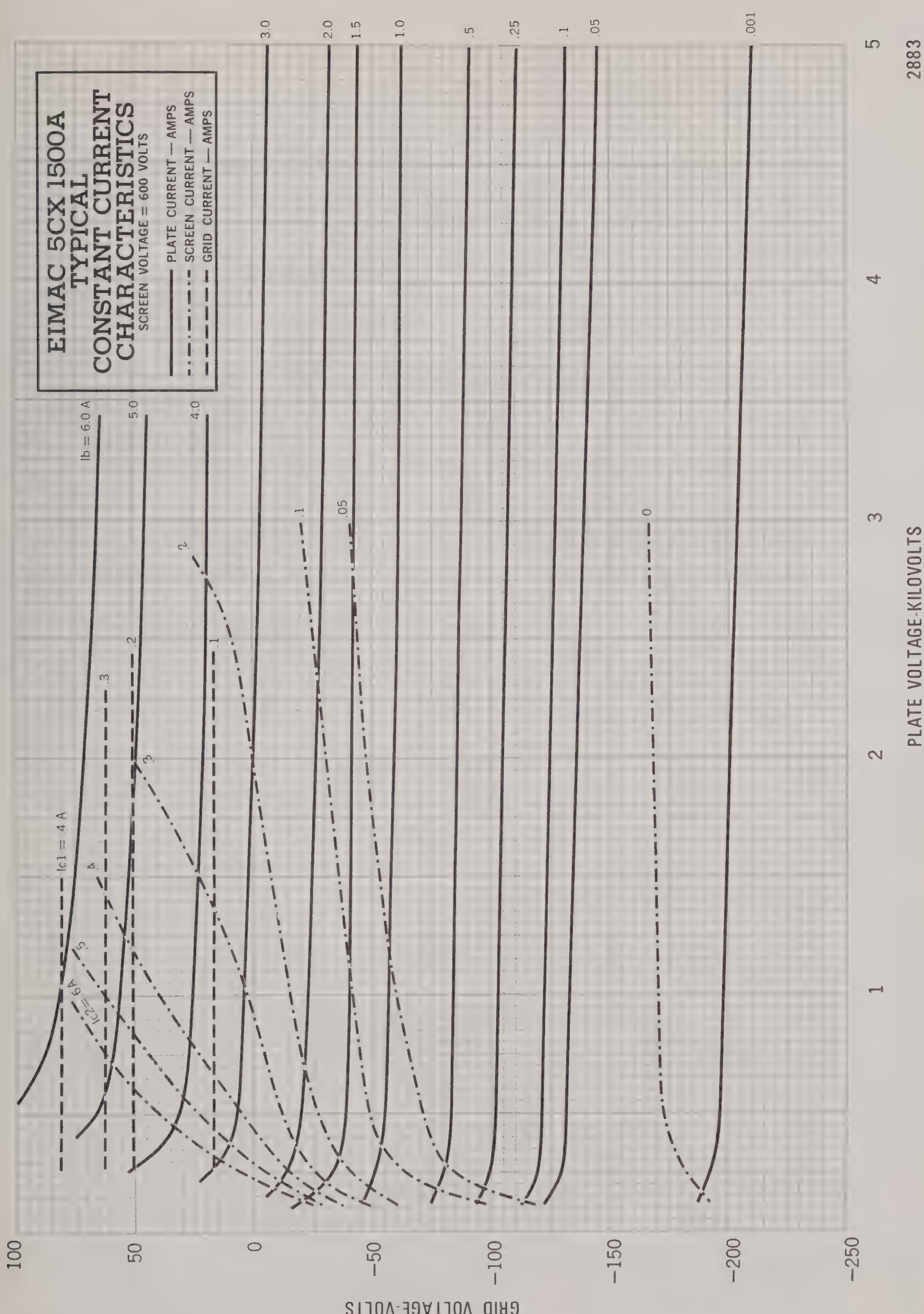
HIGH VOLTAGE - The 5CX1500A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

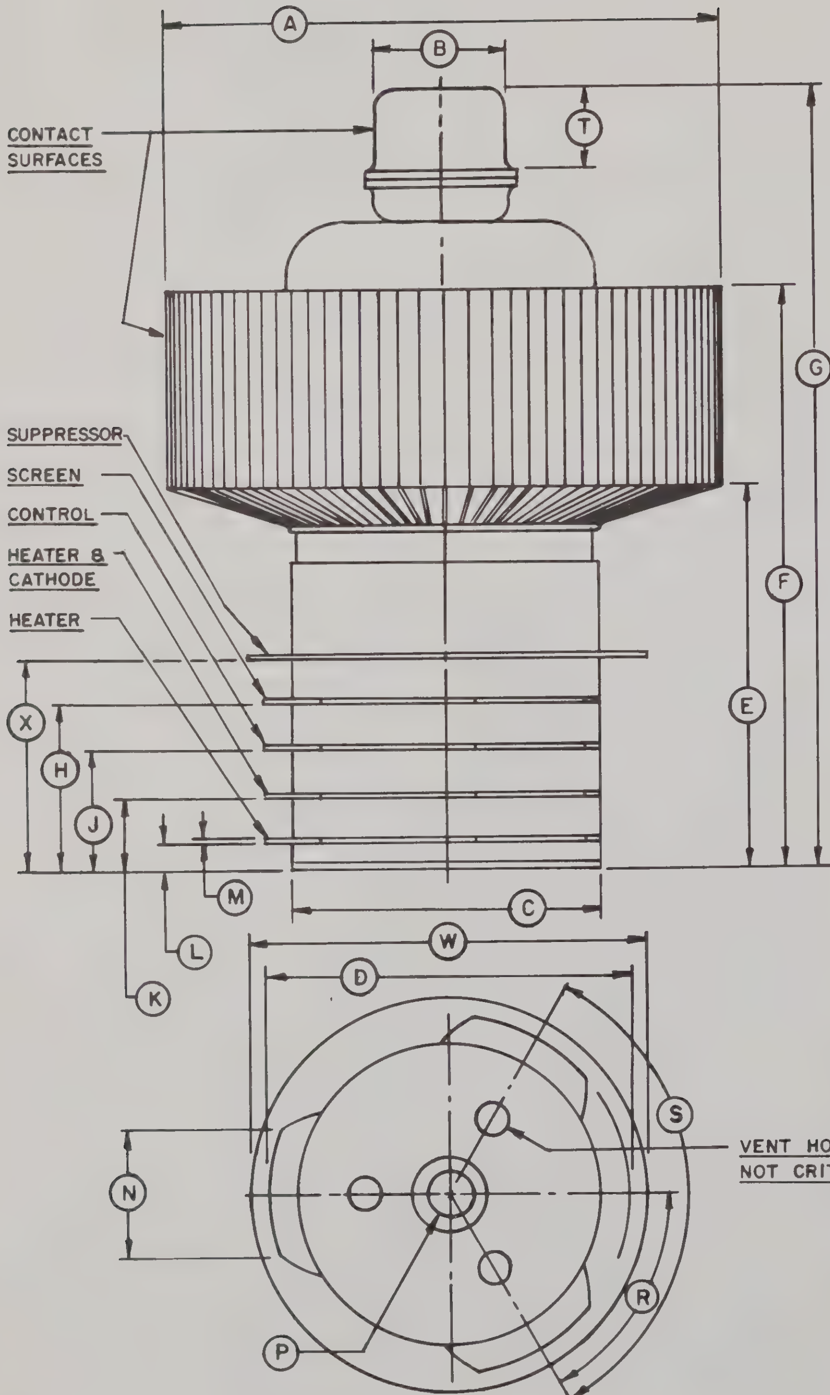
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here write to the Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


EIMAC 5CX 1500A
IM PRODUCTS vs POWER OUTPUT
(AS A FUNCTION OF ZERO-SIGNAL PLATE CURRENT)
3rd Order Products
5th Order Products
Eb = 4000 VOLTS, Ec2 = 500 VOLTS
Ec3 = 0 VOLTS, RL = 3500 OHMS
F1 = 1.980 Mc, F2 = 1.982 Mc
Ibo = 200 mAdc
Ibo = 250 mAdc
Ibo = 300 mAdc
200
250
300
0 db
−10 db
−20 db
−30 db
−40 db
−50 db
−60 db
−70 db
IM PRODUCTS (db BELOW EITHER OF TWO SINGLE TONES)
0
500
1000
1500
2000
2500
POWER OUTPUT (PEP)—WATTS


EIMAC 5CX 1500A
IM PRODUCTS vs POWER OUTPUT
(AS A FUNCTION OF ZERO-SIGNAL PLATE CURRENT)
3rd Order Products
5th Order Products
Eb = 4000 VOLTS, Ec2 = 600 VOLTS
Ec3 = 0 VOLTS, RL = 2800 OHMS
F1 = 1.980 Mc, F2 = 1.982 Mc
Ibo = 200 mAdc
Ibo = 250 mAdc
Ibo = 300 mAdc
200
250
300
0 db
−10 db
−20 db
−30 db
−40 db
−50 db
−60 db
−70 db
IM PRODUCTS (db BELOW EITHER OF TWO SINGLE TONES)
0
500
1000
1500
2000
2500
POWER OUTPUT (PEP)—WATTS


EIMAC 5CX 1500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 6.0 A
5.0
4.0
3.0
2.0
1.5
1.0
.5
.25
.1
.05
.001
Ic2 = 1.0 A
.75
.5
.4
.3
.25
.2
.1
.05
0
Ic1 = .5 A
.3
.2
.1
PLATE VOLTAGE-KILOVOLTS
GRID VOLTAGE-VOLTS
2882


EIMAC 5CX 1500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 600 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 6.0 A
5.0
4.0
3.0
2.0
1.5
1.0
.5
.25
.1
.05
.001
Ic1 = .4 A
.3
.2
.1
Ic2 = .6A
.5
.4
.3
.2
.1
.05
0
GRID VOLTAGE-VOLTS
100
50
0
−50
−100
−150
−200
−250
PLATE VOLTAGE-KILOVOLTS
1
2
3
4
5
2883



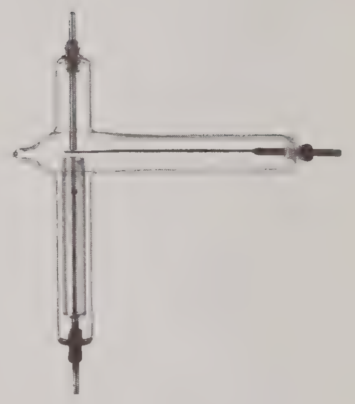
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN.	MAX	REF
A	3.335	3.370	- -	84.71	85.60	- -
B	0.807	0.820	- -	20.50	20.83	- -
C	1.870	1.900	- -	47.50	48.26	- -
D	2.250 DIA	2.300 DIA	- -	57.15 DIA	58.42 DIA	- -
E	2.335	2.535	- -	59.31	64.39	- -
F	3.530	3.730	- -	89.66	94.74	- -
G	4.900	5.150	- -	124.46	130.81	- -
H	0.965	0.988	- -	24.51	25.09	- -
J	0.690	0.710	- -	17.53	18.03	- -
K	0.415	0.435	- -	10.54	11.05	- -
L	0.140	- -	- -	3.56	-.-	- -
M	0.020	0.030	- -	0.51	0.76	- -
N	0.700	0.800	- -	17.78	20.32	- -
P	0.314 DIA.	0.326 DIA.	- -	7.98 DIA.	8.28 DIA	- -
R	55°	65°	- -	55°	65°	- -
S	115°	125°	- -	115°	125°	- -
T	0.470	0.530	- -	11.94	13.46	- -
W	2.468	2.531	- -	62.69	64.29	- -
X	1.225	1.275	- -	31.12	32.39	- -
			- -			- -

TECHNICAL DATA

VS-2
VS-4
VS-6

VACUUM SWITCH

EIMAC VS-2, VS-4 and VS-6 are single pole, double throw, electromagnetically actuated vacuum switches designed for high voltage applications where a compact, fast-acting vacuum switch is required.



The VS-2 and VS-4 are identical electrically and are intended for switching radio-frequency circuits at moderate values of current. These two switches differ only in physical characteristics, the VS-4 being shorter.

The VS-6 is intended for pulse switching applications where high peak currents are encountered. These switches are designed to be used with EIMAC 12 volts and 24 volts direct-current coils.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

	VS-2	VS-4	VS-6	
Peak rf hold-off voltage	20,000	20,000	22,000	volts
Rf Contact Current (1-15 MHz)	7.5	7.5		amperes
(30 MHz)	5.0	5.0		amperes
Pulse Current (see note)			150	amperes

(Note) Pulse duration less than 2.5 microseconds, pulse repetition rate less than 400 pps.
Pulse train = 0.5 seconds.

Maximum Contact Resistance:

	VS-2	VS-4	VS-6	
Normally closed contact	0.03	0.03	0.03	ohms
Normally open contact	0.05	0.05	0.05	ohms
Maximum Contact closing time	20	20	20	millisec.

MECHANICAL

Dimensions . . . . . . See drawings
Weight (Approximate) . . . . . . 2 oz; 56.7 gm

Coil Data:

	12 volt coil	24 volt coil	
Part Number	051270	051271	
Resistance (nominal)	30	115	ohms

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

EIMAC division of varian / 301 industrial way / san carlos / california 94070

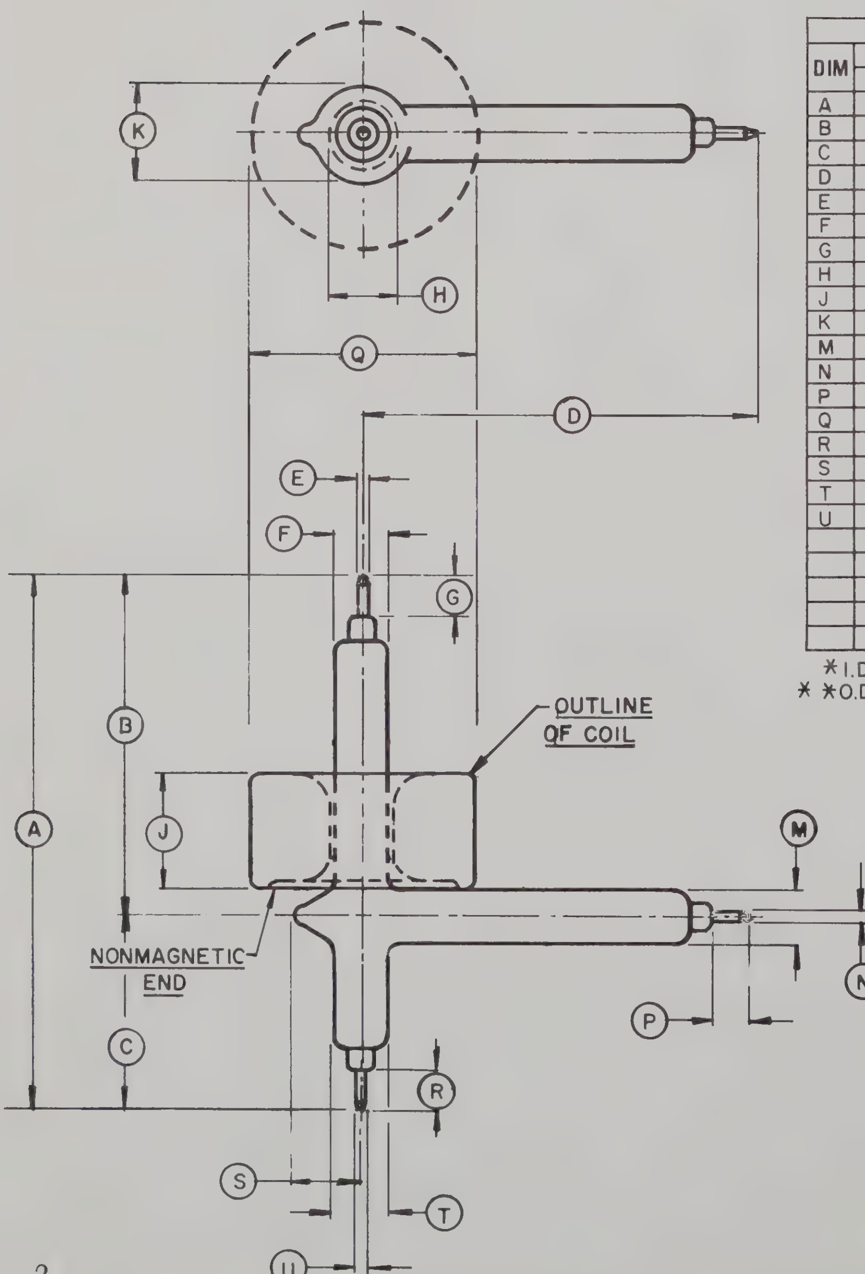
MOUNTING - The operating coil is mounted in rubber grommets over the glass barrel on the arm containing the iron core. The non-magnetic end of the coil is placed toward the contacts.

In order to prevent damage from shock and vibration, the switch should be fastened to the equipment with rubber covered metal strips over the glass tubing.

CONTACTS - The normally open contact is housed in the glass barrel containing the iron core: the normally closed contact being directly oposite this core.

DC RATINGS - While not designed for dc applications, the VS series may be used at reduced ratings in dc service. The following ratings have been established:

	VS-2	VS-4	VS-6	
Voltage -	14,000	14,000	14,000	Vdc
Current -	4	4	6	Adc



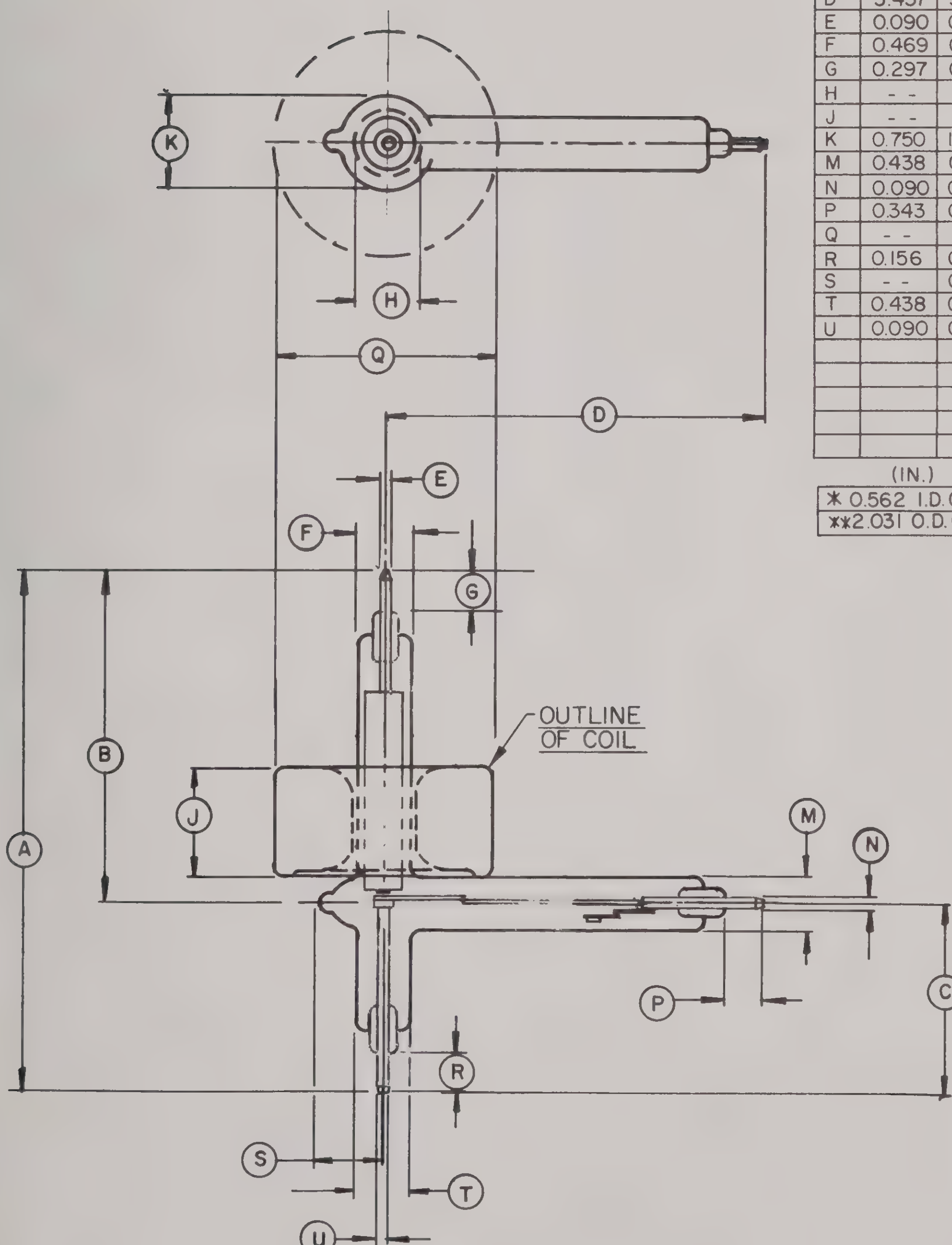
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.750	4.875	- -	120.65	123.82	- -
B	3.000	3.125	- -	76.20	79.37	- -
C	1.687	1.812	- -	42.85	46.02	- -
D	3.437	3.562	- -	87.30	90.47	- -
E	0.090	0.103	- -	2.29	2.62	- -
F	0.468	0.531	- -	11.89	13.49	- -
G	0.343	0.406	- -	8.71	10.31	- -
H	- -	- -	9/16 *	- -	- -	4.76 *
J	- -	- -	1.031	- -	- -	26.19
K	0.750	1.000	- -	19.05	25.40	- -
M	0.437	0.562	- -	11.10	14.27	- -
N	0.090	0.103	- -	2.29	2.62	- -
P	0.343	0.406	- -	8.71	10.31	- -
Q	- -	- -	2-1/32**	- -	- -	51.59**
R	0.343	0.406	- -	8.71	10.31	- -
S	- -	0.750	- -	- -	19.05	- -
T	0.437	0.562	- -	11.10	14.27	- -
U	0.090	0.103	- -	2.29	2.62	- -

* I.D. COIL
** O.D. COIL

VS-2

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.453	4.577	- -	113.11	116.25	- -
B	2.922	3.046	- -	74.22	77.37	- -
C	1.469	1.593	- -	37.31	40.46	- -
D	3.437	3.562	- -	87.30	90.47	- -
E	0.090	0.103	- -	2.29	2.62	- -
F	0.469	0.531	- -	11.91	13.49	- -
G	0.297	0.359	- -	7.54	9.12	- -
H	- -	- -	*	- -	- -	*
J	- -	- -	1.031	- -	- -	26.19
K	0.750	1.000	- -	19.05	25.40	- -
M	0.438	0.562	- -	11.12	14.27	- -
N	0.090	0.103	- -	2.29	2.62	- -
P	0.343	0.406	- -	8.71	10.31	- -
Q	- -	- -	**	- -	- -	**
R	0.156	0.218	- -	3.96	5.54	- -
S	- -	0.750	- -	- -	19.05	- -
T	0.438	0.562	- -	11.12	14.27	- -
U	0.090	0.103	- -	2.29	2.62	- -

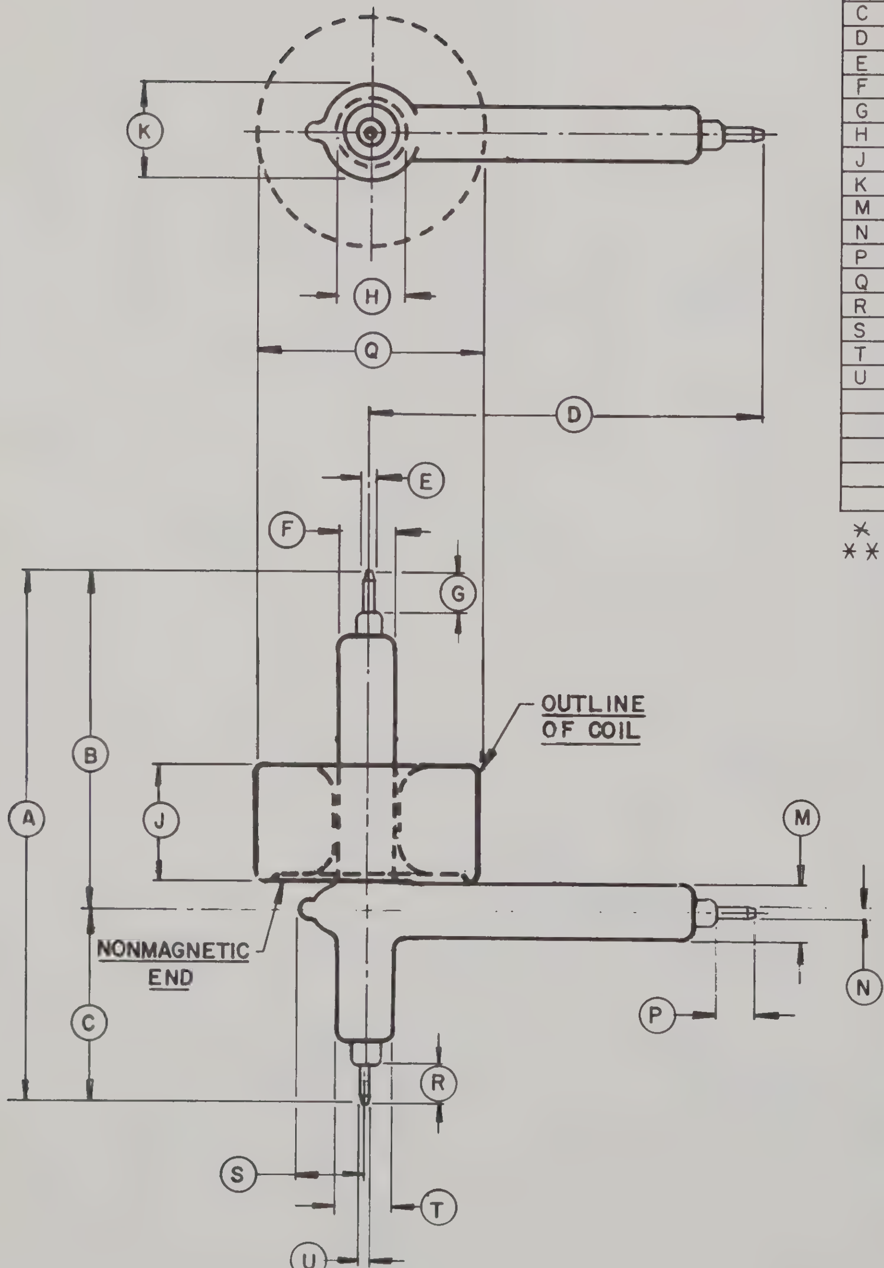
(IN.)	(MM)
* 0.562 I.D. COIL	
**2.031 O.D. COIL	51.59 O.D. COIL



VS-4

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.750	4.875	- -	120.65	123.82	- -
B	3.000	3.125	- -	76.20	79.37	- -
C	1.687	1.812	- -	42.85	46.02	- -
D	3.437	3.562	- -	87.30	90.47	- -
E	0.090	0.103	- -	2.29	2.62	- -
F	0.484	0.515	- -	12.29	13.08	- -
G	0.343	0.406	- -	8.71	10.31	- -
H	- -	- -	9/16 *	- -	- -	4.76 *
J	- -	- -	1.031	- -	- -	26.19
K	0.750	1.000	- -	19.05	25.40	- -
M	0.468	0.531	- -	11.89	13.49	- -
N	0.090	0.103	- -	2.29	2.62	- -
P	0.343	0.406	- -	8.71	10.31	- -
Q	- -	- -	2-1/32**	- -	- -	51.59**
R	0.343	0.406	- -	8.71	10.31	- -
S	- -	0.750	- -	- -	19.05	- -
T	0.468	0.531	- -	11.89	13.49	- -
U	0.090	0.103	- -	2.29	2.62	- -

* I.D. COIL
** O.D. COIL



VS-6

TECHNICAL DATA

SK-630
SK-630A
AIR-SYSTEM SOCKET

The EIMAC SK-630 is one of the Air-System Sockets recommended for use with those tubes listed on the back of this data sheet or other tube types having the same special nine-pin base. A ceramic SK-626 Air Chimney or a fiberglass-reinforced silicone resin SK-636 Air Chimney are also available and are recommended for use with the socket when air-cooled tubes are to be employed.

When this socket is used, connection is made to each of the tube electrodes except the anode, and to one side of the integral screen-grid by-pass capacitor. The SK-630 Air-System Socket is humidity and salt-spray resistant. The SK-630A is an improved SK-630 which includes a slightly modified screen by-pass capacitor sealed with an improved encapsulating material to insure reliable performance under high humidity or moisture conditions.

BASE CONNECTIONS

The SK-630 Air-System Socket consists of eight screen-grid contact fingers, seven pin contacting terminals (no contact is made to pin No. 5), a center control-grid terminal, and an integral screen by-pass capacitor. The cathode of the tube is connected to its external circuits by the four even-numbered base pins which are connected in parallel to minimize the effects of lead inductance. These terminal lugs are connected directly to the metal shell of the socket and will automatically be grounded when the socket is mounted to a metal chassis.

SCREEN-GRID BY-PASS CAPACITOR

Incorporated in the socket structure is a low-inductance screen by-pass capacitor, 1100 pF ±20%, which provides a short radio-frequency path to ground. The silvered-mica dielectric, encapsulated in epoxy resin, is humidity and salt-spray resistant. The sockets are hi-voltage breakdown tested at 2000 volts dc and are rated for use at 1000 volts dc.

When this socket is mounted on a grounded chassis, one side of the screen-grid by-pass capacitor will automatically be grounded.

MATERIALS AND FINISHES

The metal shell, or body, of the socket is silver-plated brass. The screen-grid contact fingers and base pin terminals are fabricated of beryllium-copper, heat-treated after forming, then silver-plated. The center control-grid terminal is silver-plated brass as are the toe clamps which are supplied for mounting purposes.

The socket insulating material, polytrifluorochloroethylene, is chemically inert, non-flammable, will not absorb water or water vapors, and is not affected by acids or alkalies. It will not react to normal solvents, except in the case of halogenated compounds which will induce minor dimensional changes. Its physical characteristics are stable over a temperature range of -196°C to +199°C and it is resistant to embrittlement and thermal shock.

NET WEIGHT (Approximate) . . . . 4 Oz.; 114 gms

INSTALLATION

The SK-630 and SK-630A Air-System Socket can be mounted on chassis decks or partitions or in coaxial tuning devices with no modification to the socket. Chassis mounting is accomplished by cutting a 2-1/4" diameter hole in the chassis deck or partition. The socket is then placed in the hole and held securely by the three toe clamps provided.

If the socket is to be used in a coaxial line, it may be mounted directly on the end of the input line outer conductor. The socket skirt fits snugly on a 1-5/8" diameter cylinder and four screw holes are provided for fastening as shown in the outline drawing.

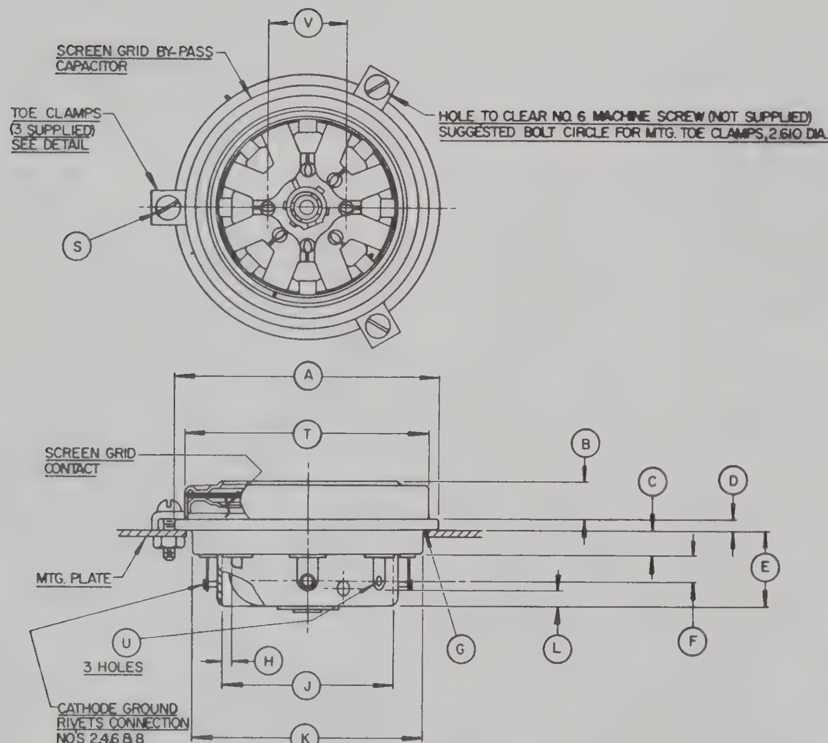
(Cont'd)

TUBE EXTRACTOR

The SK-604 is a spring-steel device useful for inserting and extracting tubes of the type used in the SK-630 Air-System Socket. It is recommended for use where the construction of the equipment makes it difficult or impossible to grasp the tube by hand or when it is necessary to handle the tubes while they are still hot from recent use.

THE SK-630 AND SK-630A AIR-SYSTEM SOCKETS ARE RECOMMENDED FOR USE WITH THE FOLLOWING TUBES:

7034/4X150A	8249/4W300B	8904/4CX350FJ
7203/4CX250B	8321/4CX350A	8930
7580W/4CX250R	8322/4CX350F	8957/4CX250BC
7609	8621/4CX250FG	

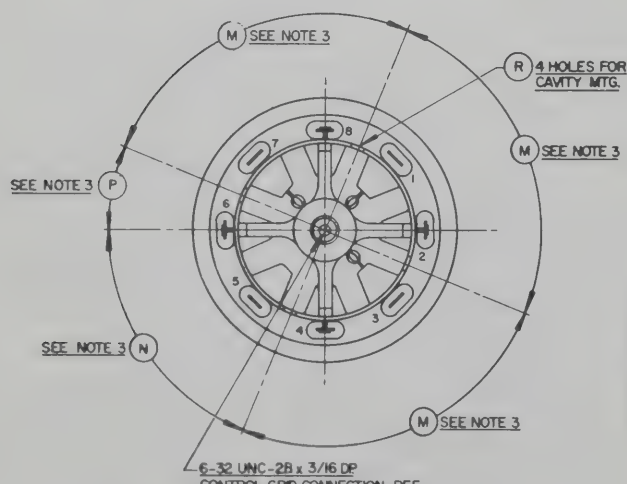


DIMENSIONAL DATA

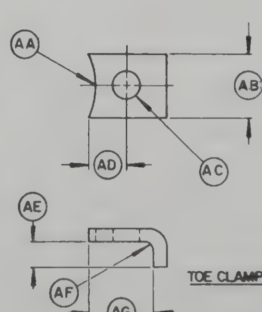
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.438	2.478	- -	61.92	62.94	- -
B	0.348	0.378	- -	8.84	9.60	- -
C	0.203	0.235	- -	5.16	5.97	- -
D	0.105	0.145	- -	2.67	3.68	- -
E	0.700	0.740		17.78	18.80	- -
F	- -	- -	0.250	- -	- -	6.35
G	- -	0.031R	- -	- -	0.79R	- -
H	- -	- -	0.078	- -	- -	1.98
J	1.633	1.643	- -	41.48	41.73	- -
K	2.188	2.208	- -	55.57	56.08	- -
L	0.172	0.204	- -	4.37	5.18	- -
M	89°	91°	- -	89°	91°	- -
N	66.5°	68.5°	- -	66.5°	68.5°	- -
P	21.5°	23.5°	- -	21.5°	23.5°	- -
R	- -	- -	0.144*	- -	- -	3.66*
S	0.142*	- -	- -	3.61*	- -	- -
T	2.285	2.305	- -	58.04	58.55	- -
U	- -	- -	0.090*	- -	- -	2.29*
V	- -	- -	0.687	- -	- -	17.45
AA	1.230R	1.270R	- -	31.24	32.26	- -
AB	0.292	0.332	- -	7.42	8.43	- -
AC	0.142*	0.146*	- -	3.61*	3.71*	- -
AD	0.136	0.176	- -	3.45	4.47	- -
AE	0.105	0.145	- -	2.67	3.68	- -
AF	- -	0.062R	- -	- -	1.57R	- -
AG	0.261	0.301	- -	6.63	7.64	- -

* DIAMETER

NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQ'D. FOR INSPECTION PURPOSES.
2. CAPACITANCE, 1100 MMFD ±20% VOLTAGE, 2000 VDC TEST, 1000 WVDC.
3. TOLERANCES ARE NOT CUMULATIVE.
4. WORD EIMAC IN SOCKET IDENTIFICATION LABEL IS LOCATED (APPROX.) NEXT TO PIN 5.
5. GROUND CATHODE



CONNECTIONS
NO. 1 SCREEN GRID
NO. 2 CATHODE
NO. 3 HEATER
NO. 4 CATHODE
NO. 5 NO CONNECTION
NO. 6 CATHODE
NO. 7 HEATER
NO. 8 CATHODE



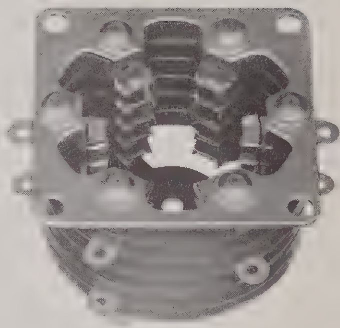
TOE CLAMP DETAIL

TECHNICAL DATA

SK-740

AIR-SYSTEM SOCKET

The EIMAC SK-740 Air-System Socket is recommended for use with those tubes listed at the bottom of the page or other tube types having this special breech-block base. This socket is not intended for use with an Air-Chimney, but is particularly useful in applications where transverse air cooling, heat-sink or immersion cooling is intended. When this socket is used, connection is made to each of the tube electrodes except the anode.



BASE CONNECTIONS

The SK-740 socket consists of five sets of ring contacts: they are from top to bottom: 1.screen-grid, 2.control-grid, 3.cathode, 4.heater, 5.heater. Each set of contacts consist of six separate contacting tabs. The tube elements are connected to their external circuits by two diametrically-opposed solder tabs. The SK-740 has no grounded contacts.

MATERIALS AND FINISHES

The mounting plate of the socket is fabricated of nickel-plated brass. The contact rings and tabs are of beryllium copper, heat-treated after forming, then silver-plated. The rivets and washers are of brass, silver and nickel-plated respectively. The ten contact terminals are solder-dipped to insure firm, dependable solder contact. The insulating wafers and the stop yoke of the socket are molded of a flameproof diallyl meta-phthalate.

INSTALLATION

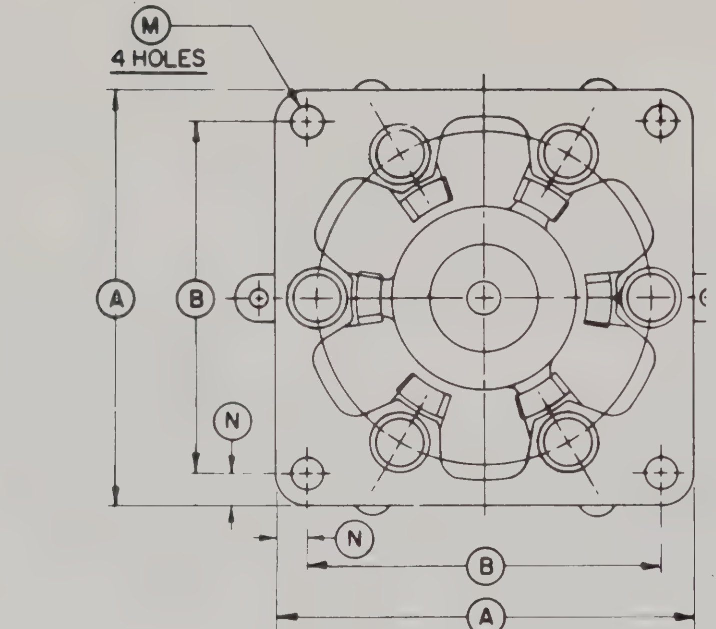
The SK-740 Air-System Socket is designed for under-chassis mounting and requires a 1.593 inches diameter hole through the chassis deck. Four screw holes are provided for fastening as shown in the outline drawing.

THE SK-740 AIR-SYSTEM SOCKET IS RECOMMENDED FOR USE WITH THE FOLLOWING TUBE TYPES:

4N15A	4CX300A/8167
4CX125C	4CX300Y/8561
4CX125F	

Note: A separate means of directing air is required when using the SK-740 with the 4CX300A and 4CX300Y. For applications using these two tubes, the SK-760 and SK-770 Air-System Sockets are recommended. These contain an integral chimney.

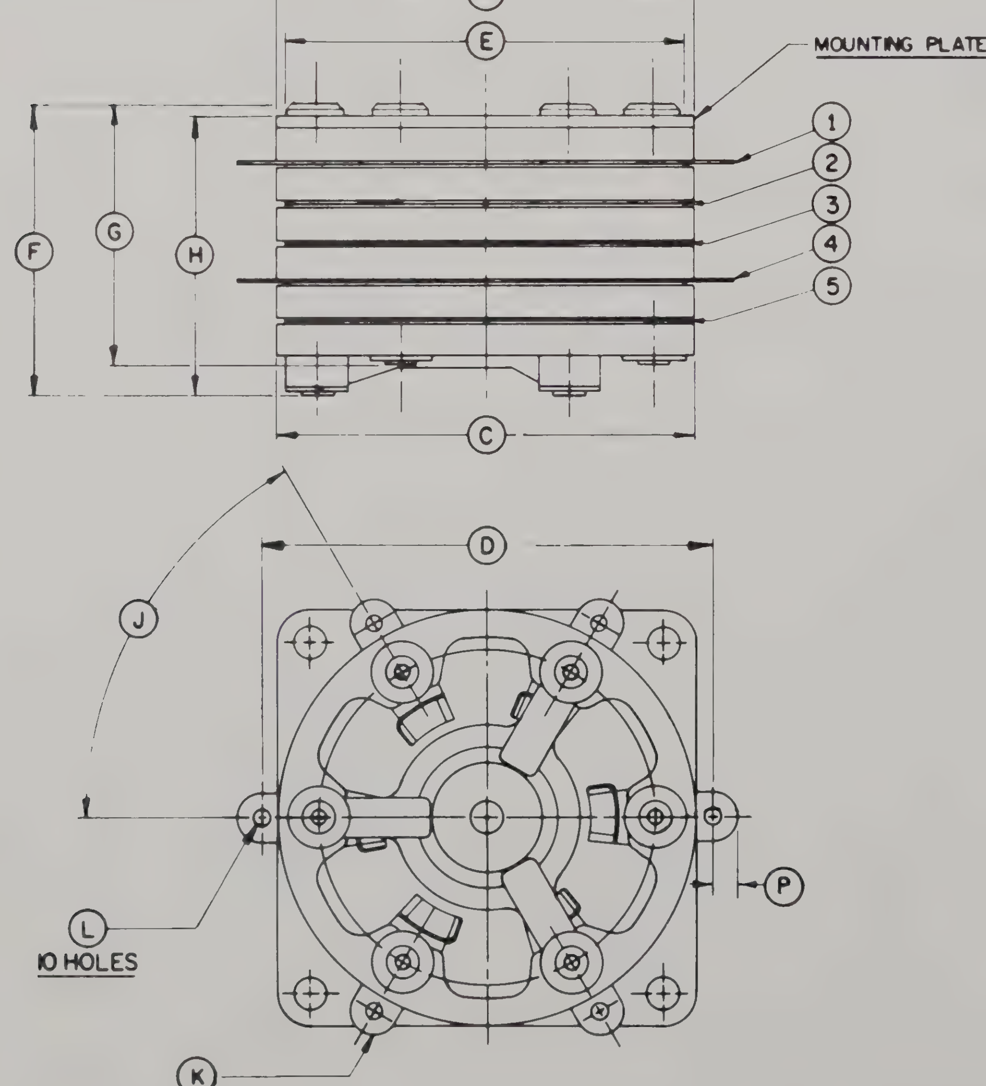
NET WEIGHT (Approximate) . . . . 1.5 Oz.; (42.5 gm)



DIM	INCHES				MILLIMETERS		
	MIN.	MAX.	REF.		MIN.	MAX.	REF.
A	1.615	1.635	- -		41.02	41.53	- -
B	1.360	1.390	- -		34.54	35.31	- -
C	1.615*	1.635*	- -		41.02*	41.53*	- -
D	1.735	1.765	- -		44.07	44.83	- -
E	1.485	1.575	- -		37.72	40.00	- -
F	1.070	1.110	- -		27.18	28.19	- -
G	0.925	0.965	- -		23.49	24.51	- -
H	1.020	1.060	- -		25.91	26.92	- -
J	- -	- -	60°		- -	- -	60°
K	- -	- -	3/32R		- -	- -	2.34R
L	- -	- -	1/16 *		- -	- -	1.57*
M	0.134*	0.154*	- -		3.40*	3.91*	- -
N	0.120	0.130	- -		3.05	3.30	- -
P	0.078	0.109	- -		1.98	2.77	- -

DIMENSIONAL DATA

* DIAMETER



CONNECTIONS

1. SCREEN GRID
2. CONTROL GRID
3. CATHODE
4. HEATER
5. HEATER

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TABLE OF CONTENTS

5-15-72

TABLE OF CONTENTS

TETRODES-PENTODES

4-65A/8165	5-1-62
4-125A/4D21	6-1-67
4-250A/5D22	5-5-70
4-400A/8438	7-20-70
4-400C/6775	4-1-71
4-500A	3-10-72
4-1000A/8166	10-30-66
4CN15A	6-1-68
4CPX250K/8590	4-1-70
4CS250R	9-1-70
4CV8000A	3-15-71
4CV20,000A	6-1-68
4CV35,000A	5-15-68
4CV50,000E	5-1-70
4CV50,000J	7-15-71
4CV75,000A	6-15-71
4CV100,000C/8351	2-1-68
4CV250,000V/A	5-1-68
4CW800B/F	3-1-68
4CW2000A/8244	6-15-71
4CW10,000A	4-15-63
4CW25,000A	2-1-72
4CW50,000E	7-1-70
4CW50,000J	7-15-71
4CW100,000D	7-1-67
4CW100,000E	9-1-70
4CW250,000V/A	3-1-71
4CX125C/F	6-1-67
4CX250B/7203 & 4CX250F/7204	5-1-70
4CX250K/8245 & 4CX250M/8246	5-1-68
4CX250R/7580W	6-16-61
4CX300A/8167	8-30-66
4CX300Y/8561	6-15-66
4CX350A/8321 & 4CX350F/8322	6-15-65
4CX350FJ/8904	9-1-71
4CX600B & 4CX600F	3-20-70
4CX600J/8809 & 4CX600JA/8921	8-15-71
4CX1000A/6168	5-1-70
4CX1000K/8352	8-20-66
4CX1500A	12-1-71
4CX1500B/8660	6-1-67
4CX3000A/8169	5-1-67
4CX5000A/8170	4-15-69
4CX5000J/8909	10-1-71
4CX5000R/8170W	4-15-71
4CX10,000D/8171	1-1-72
4CX10,000J	2-1-72
4CX15,000A/8281	5-15-71
4CX15,000J/8910	10-15-71
4CX35,000C/8349	12-1-70
4W300B/8249	5-1-70
4W20,000A/8173	4-15-64
4X150A/7034 & 4X150D/7035	5-4-70
4X150G/8172	6-15-66
4X500A	1-1-64
6816, 6884, 7843	11-15-71
6884	see 6816
7843	see 6816
8072W/8121W/8122W	7-30-71
8121W	see 8072W
8122W	see 8072W
8560A	7-15-71
8828W	2-15-72
8876	6-15-71
5-125B/4E27A	8-15-52
5-500A	5-1-68
5CX1500A	6-6-70
5CX3000A	8-1-67
264/8576	6-5-70
290	5-5-70
8295A	2-1-70

OTHER PRODUCTS

VS-2, 4, 5 & 6	4-4-70
Preformed Contact Finger Stock	6-15-71
HR Heat Dissipating Connectors	12-1-65
SK-300A	4-15-69
SK-306, SK-316	8-15-66
SK-400	4-1-56
SK-406, SK-416, SK-426	6-1-67
SK-410	11-15-62
SK-500	3-15-67
SK-506, SK-516	4-15-69
SK-510	6-15-71
SK-600A, SK-610A	6-15-71
SK-606, SK-626, SK-636B	8-15-66
SK-607	8-15-71
SK-620, SK-620A	3-15-67
SK-630, SK-630A	3-15-67
SK-640	2-15-66
SK-650, SK-655	1-15-66
SK-700, SK-710	10-15-66
SK-711A, SK-712A	3-15-71
SK-740	8-15-66
SK-760, SK-770	7-27-70
SK-800B, SK-806	4-9-64
SK-810B, SK-806	6-1-67
SK-860, SK-870	3-15-67
SK-890B, SK-806	6-1-67
SK-900, SK-906	8-15-66
SK-1300, SK-1310, SK-1320	3-1-72
SK-1306, SK-1406	8-15-66
SK-1400A, SK-1470A	10-15-66
SK-2200, SK-2210	8-15-72

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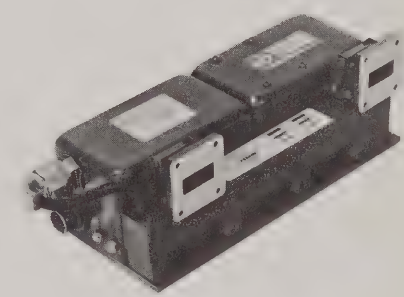
EM1184E

TRAVELING WAVE TUBE AMPLIFIER

7.9-8.4 GHz
1 Watt CW Min.

The EIMAC EM1184E Traveling Wave Tube Amplifier combines a solid-state power supply with a miniaturized high-performance CW TWT (EM1044E). The resulting package provides optimum efficiency, high gain, and minimum weight consistent with reliable long-life performance. The TWT and power supply are designed for MTBF performance in excess of 50,000 hours.

This high-gain amplifier is designed specifically as a driver for satellite communications terminal equipment. The package is also suitable for airborne, transportable and ground-based satellite communication applications where available power and space are at a premium. Excellent fine-grain gain structure and phase performance make this TWTA particularly well suited for wideband communications applications.



If applications require protection of the final power amplifier, the EM1184E can be supplied with a solid-state switch capable of instantaneously turning off the rf output when triggered by an appropriate video pulse as low as 5 volts.

CHARACTERISTICS

ELECTRICAL PERFORMANCE

Frequency Range	7.9-8.4 GHz
Saturated Power (Min.)	1.0 W
(Typical)	3.0 W
Small Signal Gain (Min.)	56 db
(Typical)	62 db
Saturated Gain (Min.)	50 db
(Typical)	56 db
Output VSWR (Typical)	2.0:1
Input VSWR (Typical)	2.0:1
Impedance (Nominal)	50 Ω
Noise Figure (Maximum)	30 db
(Typical)	27 db
Phase Linearity (10 MHz bandwidth)	±0.2 deg/MHz
Gain Slope (Maximum)	0.3 db/10 MHz
Power Supply Voltage (400 cps)	120 Vac
Power Supply Current (Nominal)	0.5 Aac

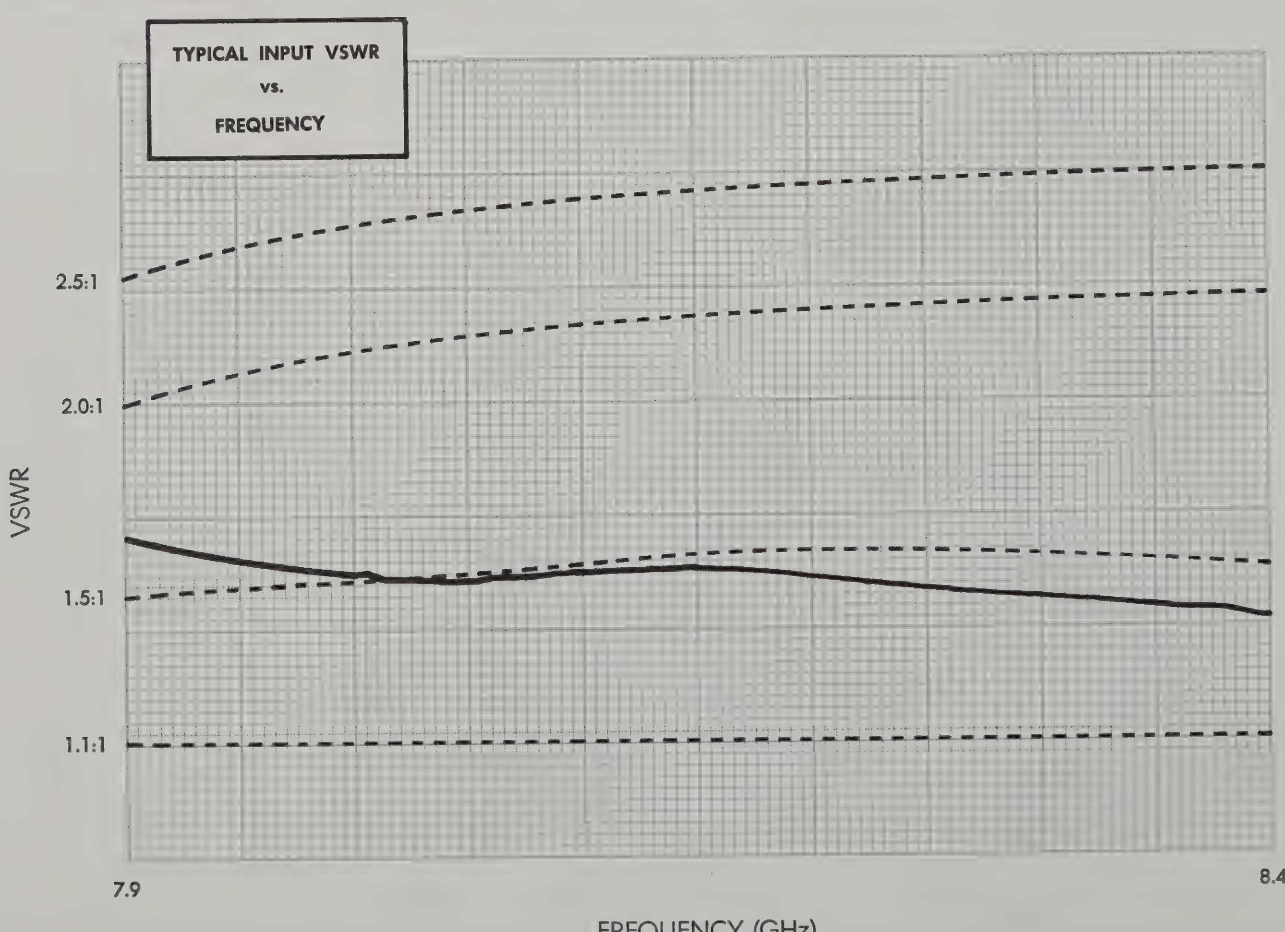
ENVIRONMENTAL PERFORMANCE

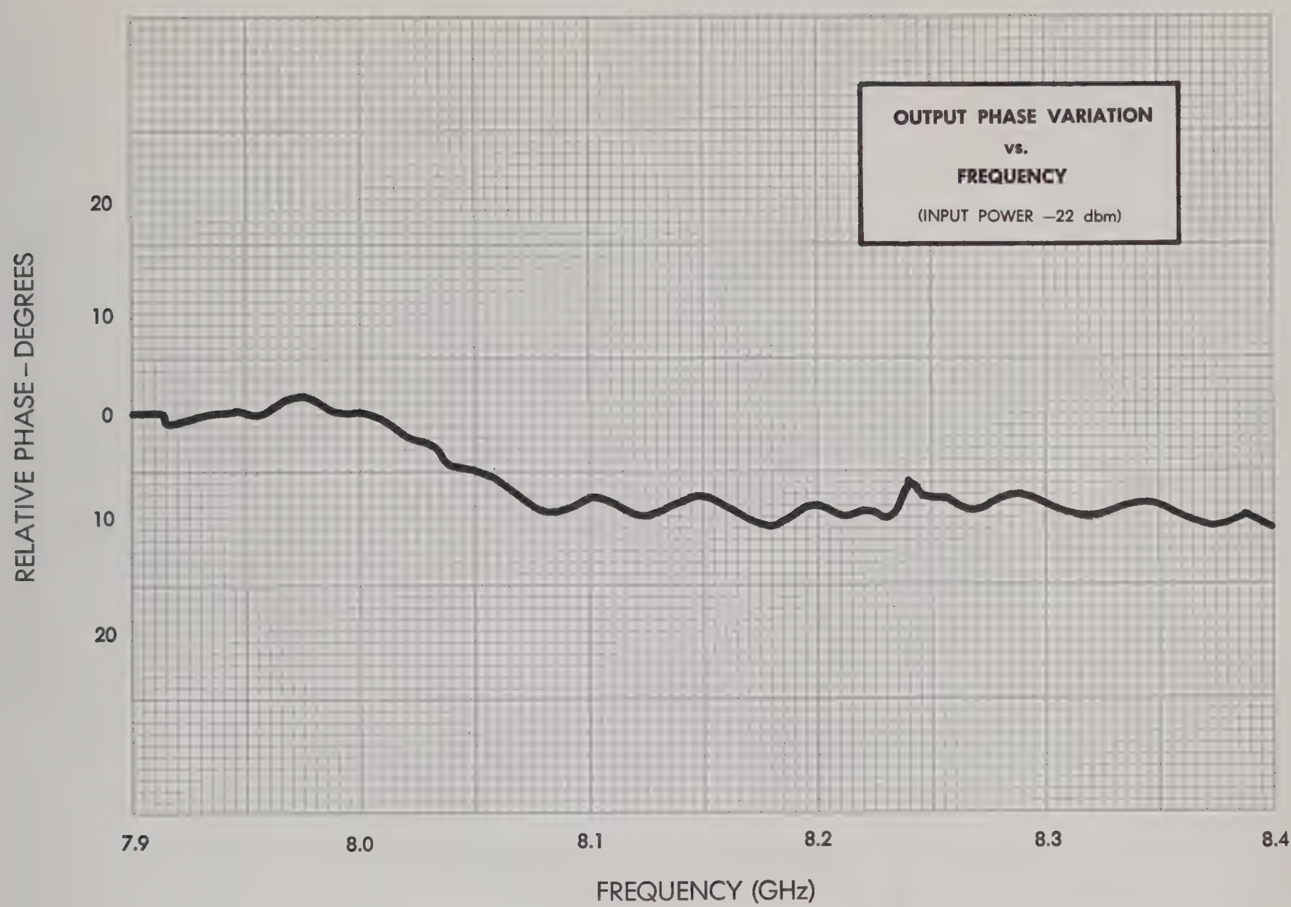
Vibration	15G, 5 to 500 cps
Shock	25G, 11 mSec
Acceleration	10G, sustained
Temperature (See Note 1)	–54°C to +85°C
Altitude (Unpressurized)	to 70,000 ft.

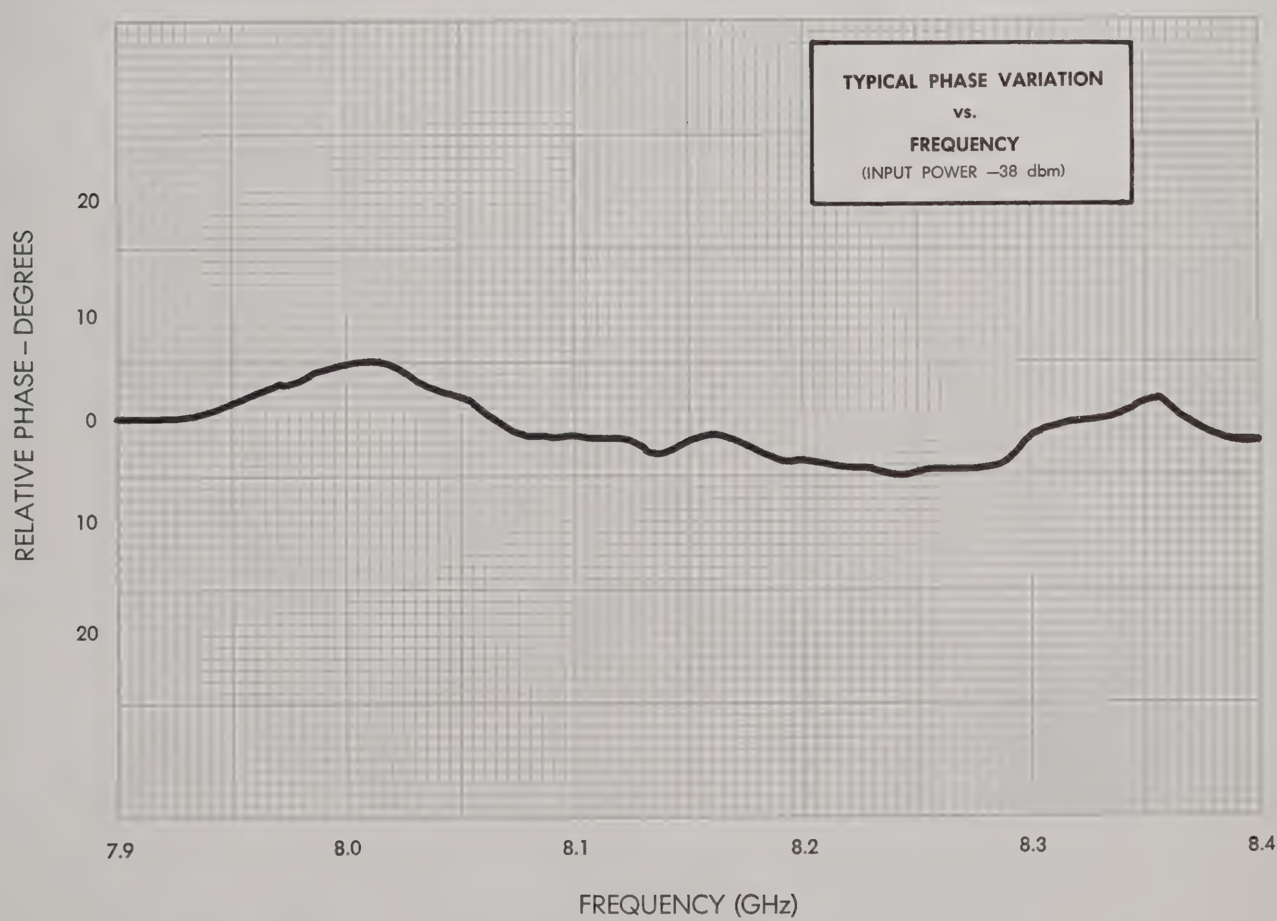
MECHANICAL CHARACTERISTICS

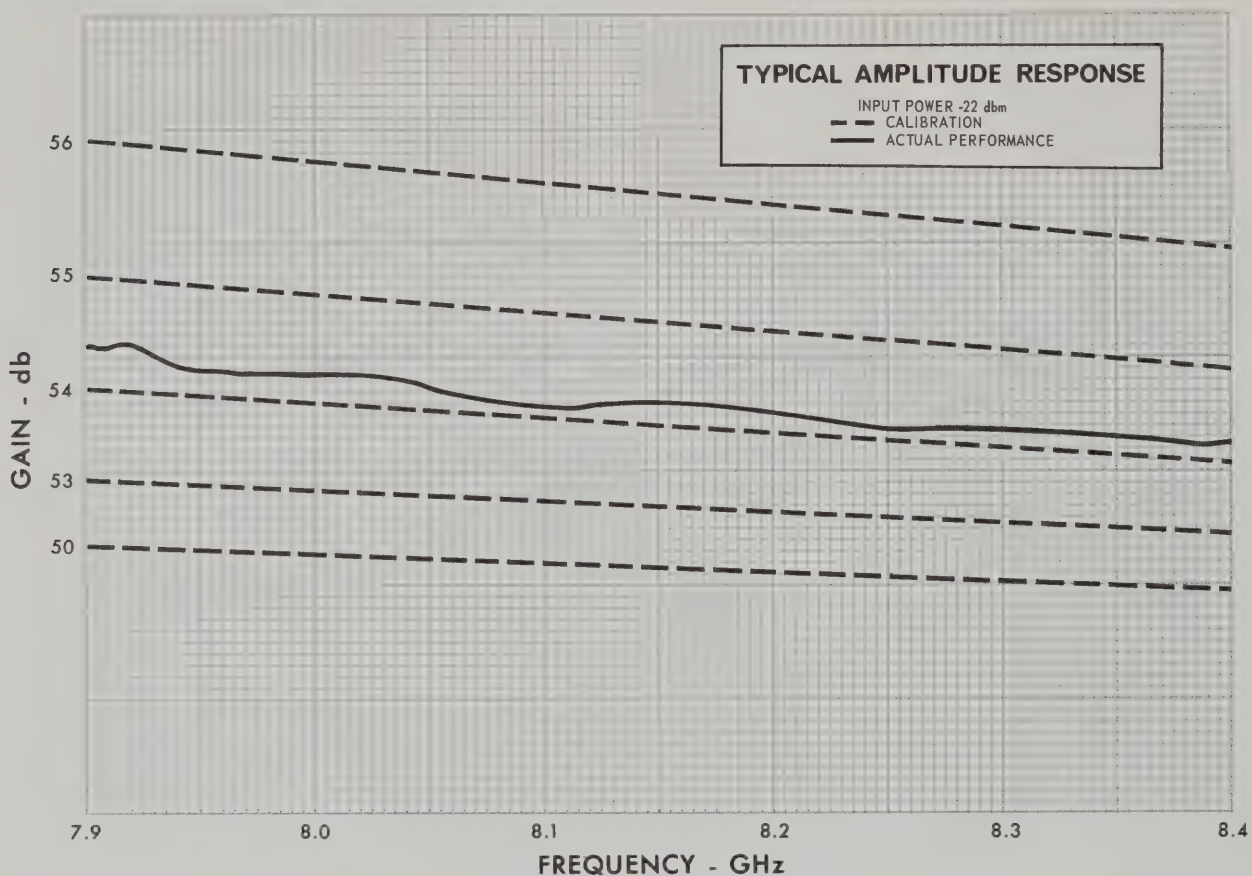
RF Input Connector	UG-138/U
RF Output Connector	UG-138/U
TWT Focusing	PPM
Cooling	Conduction through heat sink (1)
Packaging	Tube and supply on common base (2)
Mounting Position	Any
Dimensions	4½"x 3¼"x 10"
Weight (Package)	7.5 lb.
(TWT)	1.25 lb.
Mean Time Between Failure (Design)	50,000 hrs.
Power Supply Connector	MS 3124E-12-10P

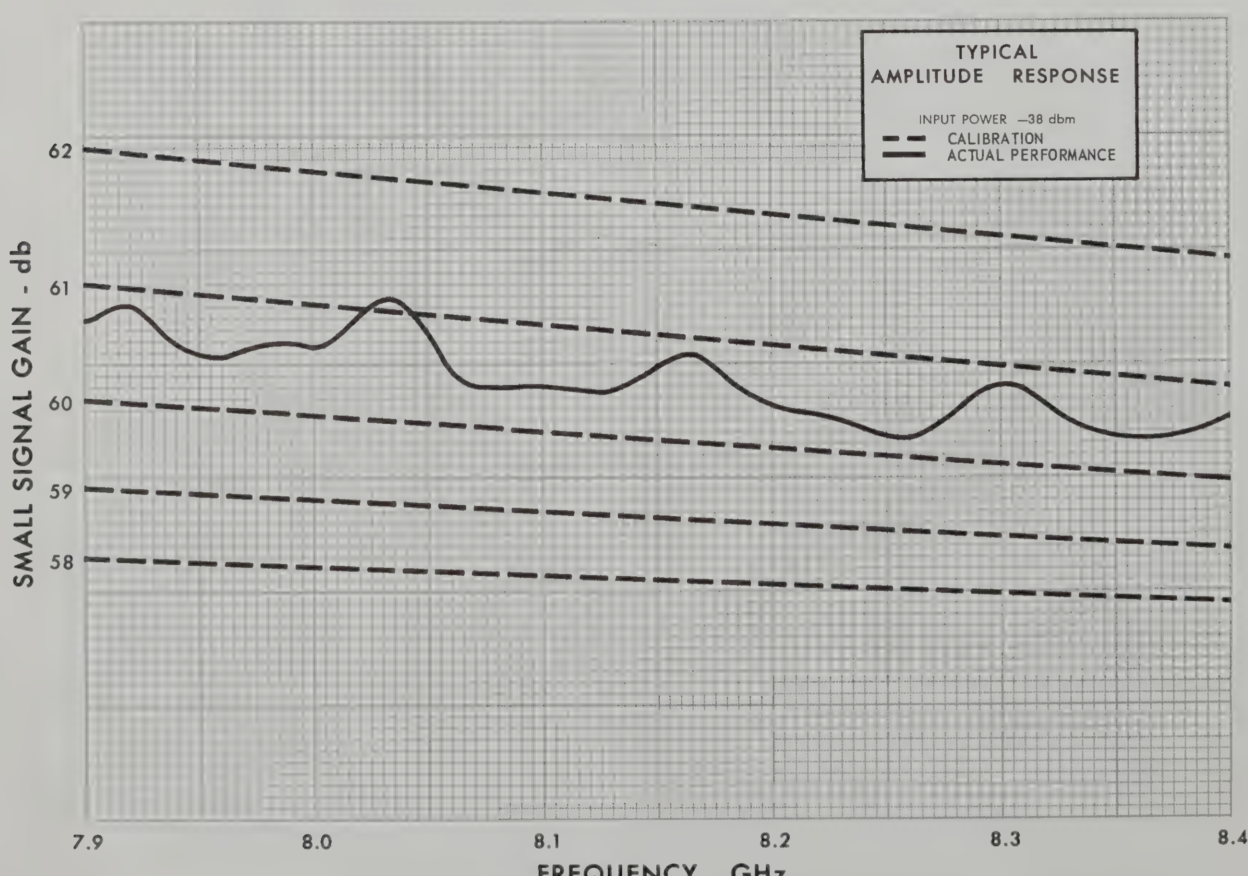
(1) TWTA base plate temperature +85°C maximum.
(2) EM1044E TWT is demountable and is available separately.

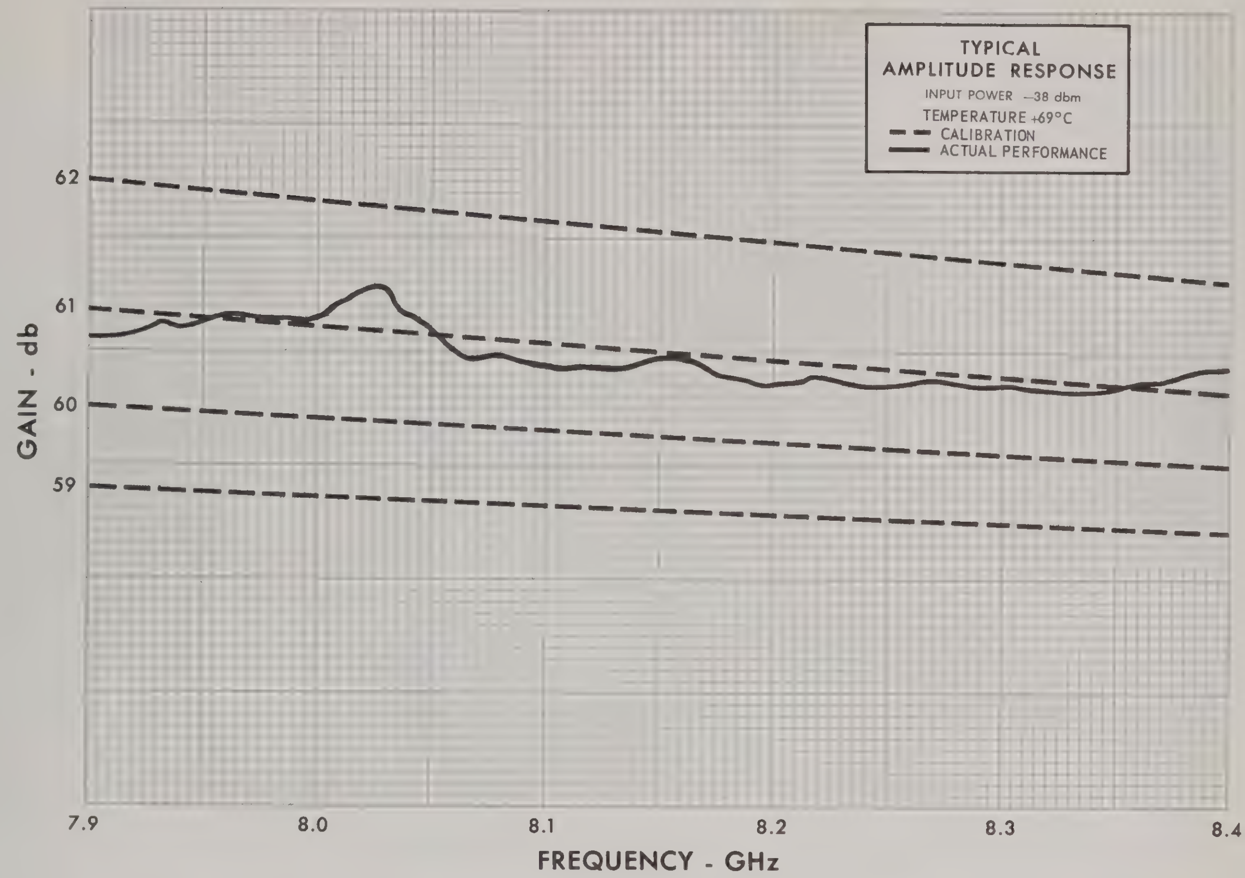


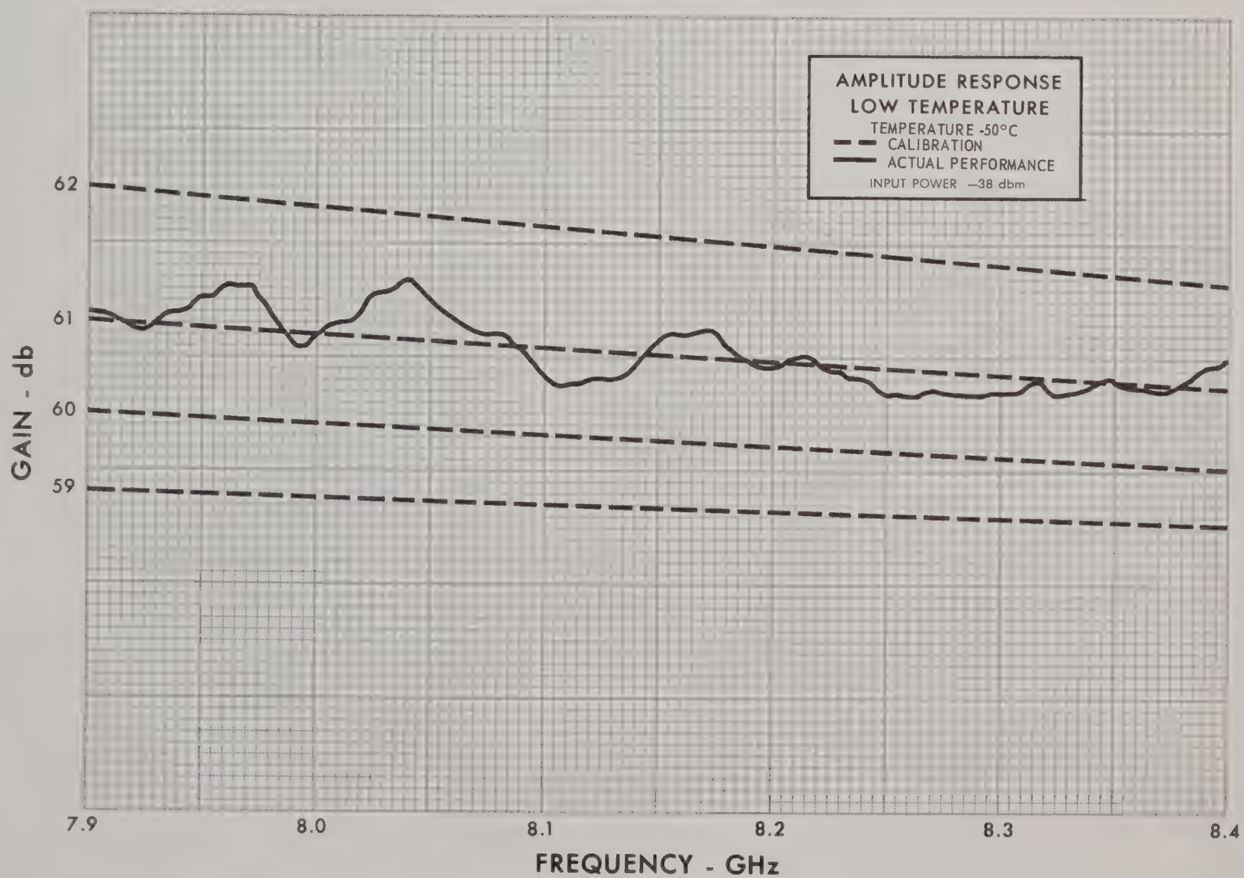

OUTPUT PHASE VARIATION
vs.
FREQUENCY
(INPUT POWER —22 dbm)
RELATIVE PHASE – DEGREES
20
10
0
10
20
7.9
8.0
8.1
8.2
8.3
8.4
FREQUENCY (GHz)

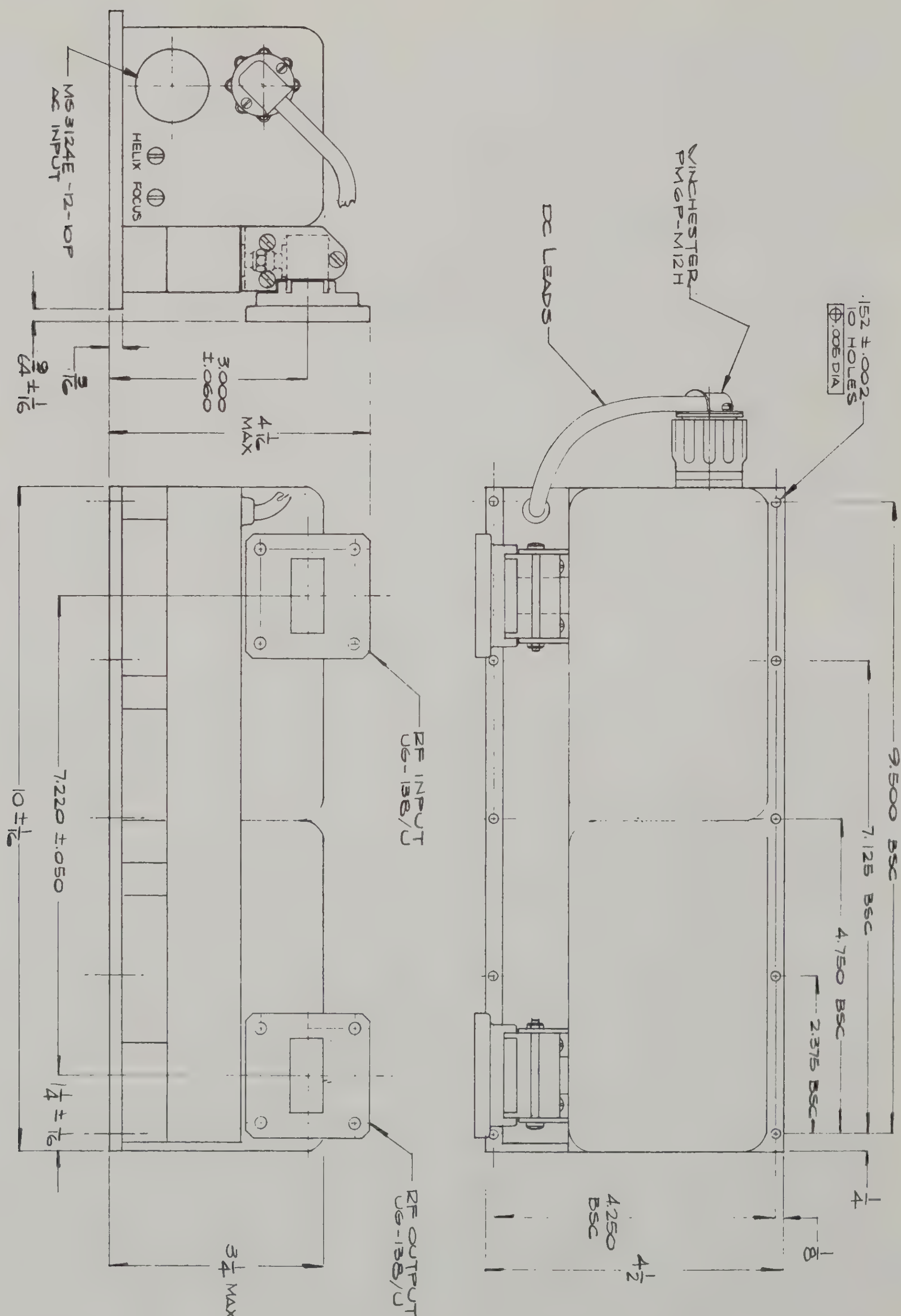

TYPICAL PHASE VARIATION
vs.
FREQUENCY
(INPUT POWER —38 dbm)
RELATIVE PHASE – DEGREES
20
10
0
10
20
7.9
8.0
8.1
8.2
8.3
8.4
FREQUENCY (GHz)


TYPICAL AMPLITUDE RESPONSE
INPUT POWER -22 dbm
CALIBRATION
ACTUAL PERFORMANCE
56
55
54
53
50
GAIN - db
7.9
8.0
8.1
8.2
8.3
8.4
FREQUENCY - GHz


TYPICAL AMPLITUDE RESPONSE
INPUT POWER —38 dbm
CALIBRATION
ACTUAL PERFORMANCE
62
61
60
59
58
SMALL SIGNAL GAIN - db
7.9
8.0
8.1
8.2
8.3
8.4
FREQUENCY - GHz


TYPICAL AMPLITUDE RESPONSE
INPUT POWER —38 dbm
TEMPERATURE +69°C
CALIBRATION
ACTUAL PERFORMANCE
62
61
60
59
GAIN - db
7.9
8.0
8.1
8.2
8.3
8.4
FREQUENCY - GHz


AMPLITUDE RESPONSE LOW TEMPERATURE
TEMPERATURE -50°C
CALIBRATION
ACTUAL PERFORMANCE
INPUT POWER —38 dbm
62
61
60
59
GAIN - db
7.9
8.0
8.1
8.2
8.3
8.4
FREQUENCY - GHz


MS3124E-12-10P
AC INPUT
HELIX FOCUS
WINCHESTER
PMGP-M12H
DC LEADS
.152 ±.002
10 HOLES
⊕ .006 DIA
3.000
±.060
4 1/16
MAX
3/16
9/64 ± 1/16
RF INPUT
UG-138/U
RF OUTPUT
UG-138/U
7.220 ±.050
10 ± 1/16
1 1/4 ± 1/16
3 1/4 MAX
9.500 BSC
7.125 BSC
4.750 BSC
2.375 BSC
1/4
1/8
4.250
BSC
4 1/2

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

4KM50LB

POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM50LB is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 350 and 475 megacycles. This klystron will deliver a narrow-band CW output power of 10 kilowatts with a minimum power gain of 43 decibels. When adjusted for wide-band operation the 4KM50LB will deliver an output power of 10 kilowatts with a half-power bandwidth of 3 megacycles and a power gain of 30 decibels.

This klystron can be pulsed or amplitude modulated with minimum power by utilizing its modulating anode. Effective protection against internal arcs is provided by connecting the modulating anode to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-153 has been designed for use with the 4KM50LB to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load coupler, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - - - - - - -	7.5	volts
	Current - - - - - - - -	40.0	amperes
	Maximum Starting Current -	80.0	amperes
	Nominal Cold Resistance - -	0.02	ohms
Cathode:	EMA, Unipotential		
	Heating Time - - - - -	5	minutes
Getter:	(Operating)		
	Voltage - - - - - - - -	2.0	volts
	Current - - - - - - - -	36.0	amperes
Power Gain: (Narrow Band) - - - -		43	decibels
Output Power - - - - - - - - - -		10	kilowatts
Frequency Range (H-153 Assembly)		350 to 475	megacycles

MECHANICAL

Operating Position - - - - - -		Axis vertical, cathode up
RF Coupling:		
	Input - - - - - - - -	Type "N" coaxial fitting
	Output - - - - - - -	3-1/8 inch, 50-ohm line
Input, 2nd and 3rd Cavity Loading - (Supplied at customer's option)		Type "N" coaxial fitting

MECHANICAL (continued)

Weights:

4KM50LB Klystron only	64 lbs (Net), 155 lbs (Gross)
H-153 RF Circuit Assembly	797 lbs (Net), 1114 lbs (Gross)

Cooling: Water and forced air.

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections in series)	1 gpm	28 psi
Klystron Collector	25 gpm	28 psi

FOCUS-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 50	volts
	Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:	Voltage	0 to 500	volts
	Current	0 to 2.5	amperes

MAXIMUM RATINGS

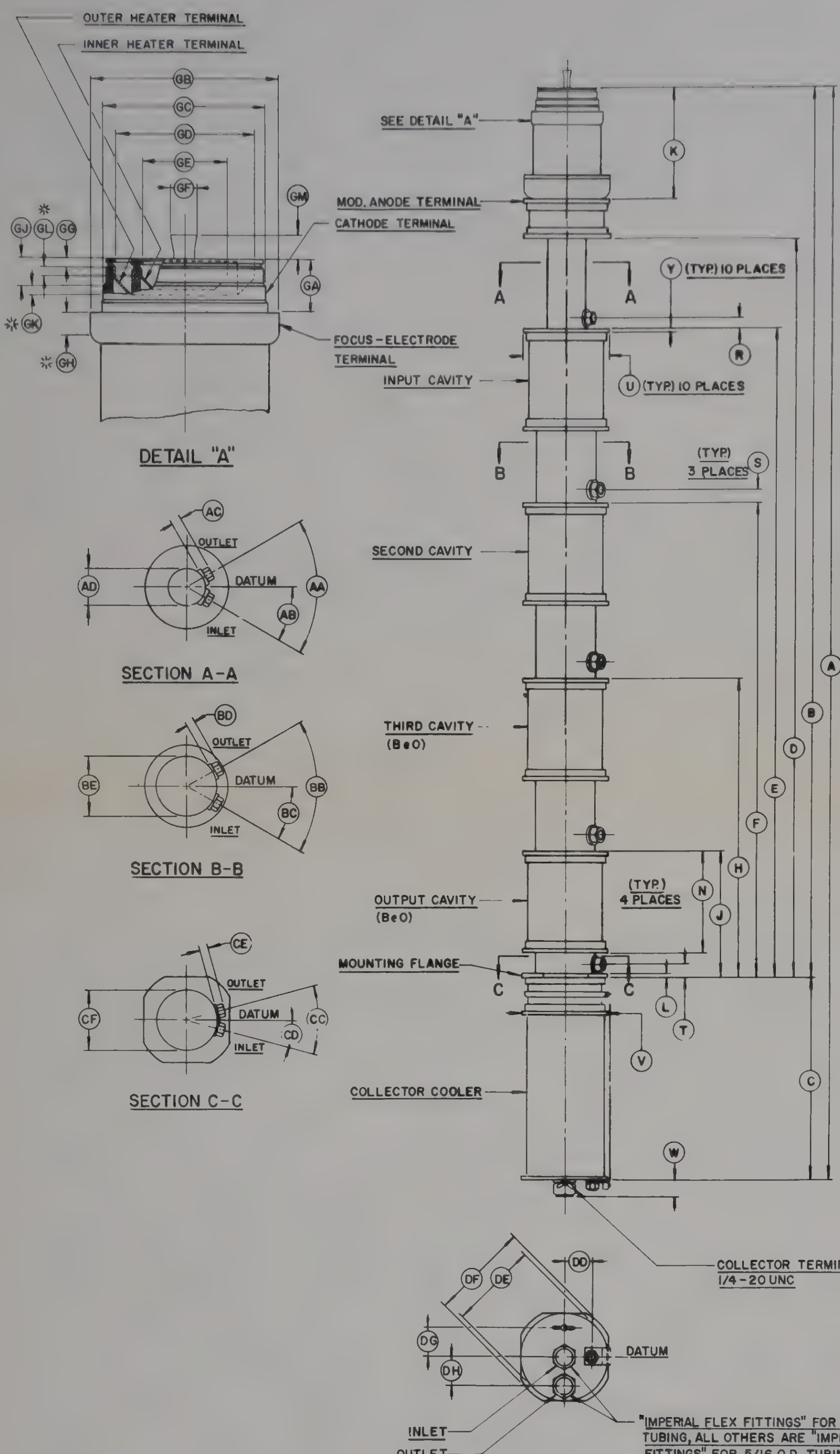
BEAM VOLTAGE	20	KILOVOLTS
BEAM CURRENT	2.5	AMPERES
BODY CURRENT (CONTINUOUS)	100	MILLIAMPERES
BODY CURRENT (TUNING ONLY)	150	MILLIAMPERES
GETTER CURRENT	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS
INLET WATER PRESSURE	50	PSI

TYPICAL OPERATION

	Narrow Band		Wide Band	
Frequency	350	475	350	megacycles
Output Power	13.5	13.8	10	kilowatts
Driving Power	0.5	0.5	6	watts
Power Gain	44.3	44.4	32.2	decibels
Beam Voltage	17	17	17	kilovolts
Beam Current	1.9	1.9	1.9	amperes
Beam Power Efficiency	41.6	42.5	31	percent
Body Current	50	45	50	milliamperes
Focus-Electrode Voltage	-200	-200	-200	volts
Half-Power Bandwidth	0.7	0.9	3	megacycles
Cavity Loading:				
1st Cavity	---	---	5	watts
2nd Cavity	---	---	40	watts
3rd Cavity	---	---	50	watts
Magnetic-Coil Currents:				
Prefocus Coil	1.20	1.16	1.05	amperes
Three Body Coils and Collector Coil in Series	2.0	2.0	2.0	amperes

* At sea level with 20° C inlet air temperature.

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.



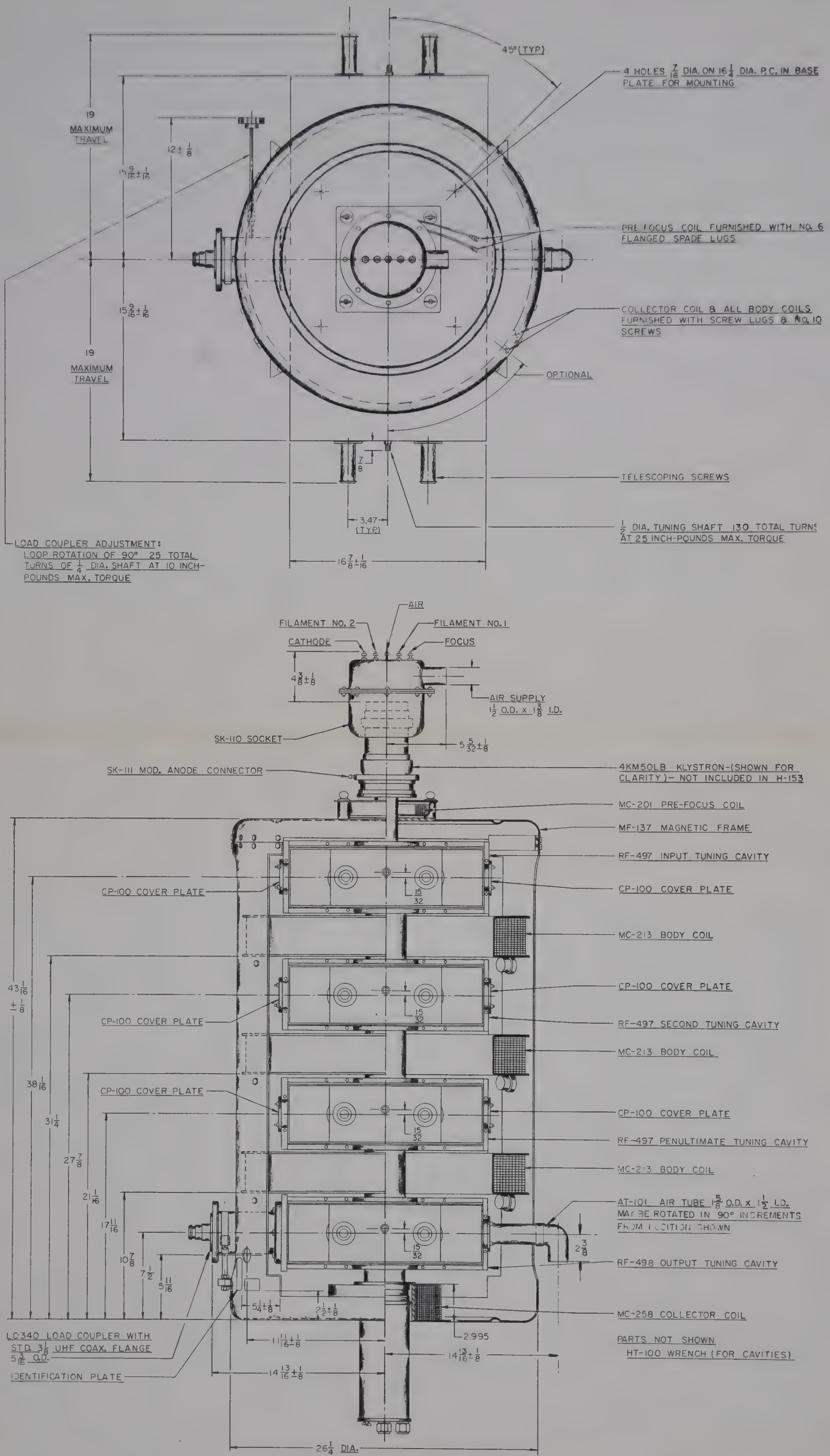
DIMENSIONAL DATA			
REF	NOM	MIN	MAX
A		60.945	61.945
B		49.575	50.075
C		11.370	11.870
D		41.600	42.000
E		37.850	38.150
F		27.730	27.900
G			
H		17.600	17.720
J		7.430	7.530
K		6.000	6.350
L		.230	.270
N		5.950	6.025
R		.840	1.100
S		.840	
T		.630	.735
U		5.105	5.145
V		4.605	4.645
W		1.000	1.100
Y		.230	.270
AA		55°	65°
AB		25°	35°
AC		.750	.900
AD		2.100	2.150
BB		55°	65°
BC		25°	35°
BD		.750	.900
BE		3.480	3.520
CC		25°	35°
CD		10°	20°
CE		.750	.900
CF		3.480	3.520
DD		1.500	1.750
DE			4.750
DF		5.105	5.145
DG		1.500	1.750
DH		1.500	1.750
GA		1.000	1.500
GB		4.300	4.450
GC		3.750	3.835
GD		3.100	3.200
GE		1.865	1.950
GF			1.188
GG		.125	.175
GH		.500	
GJ		.670	.775
GK		.100	
GL		.100	
GM			1.750

NOTES:
1. ALL DIMENSIONS ARE IN INCHES.
2. * MINIMUM STRAIGHT SURFACE FOR CONTACT.

4KM50LB KLYSTRON

4KM50LB Eimac

Eimac 4KM50LB



H-153 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM-1093

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 2.475 - 2.725

MINIMUM OUTPUT POWER 1.75 W

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	2475-2725 Mc
Anode Voltage	1100-1200 V
Cathode Current	12-20 mA
Typical Output Power	2-3 W
Anode FM Sensitivity	2.5 Mc/volt
Injection Anode Voltage	300 V
Injection Anode Current	0.0 mA
Heater Voltage (AC) (DC)	6.3 V
Heater Current (AC) (DC)	.65 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	1500 V
Cathode Current	25 mA
Injection Anode Voltage	400 V
Injection Anode Current	0.5 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

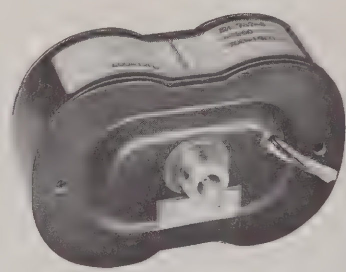
Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds

ENVIRONMENTAL

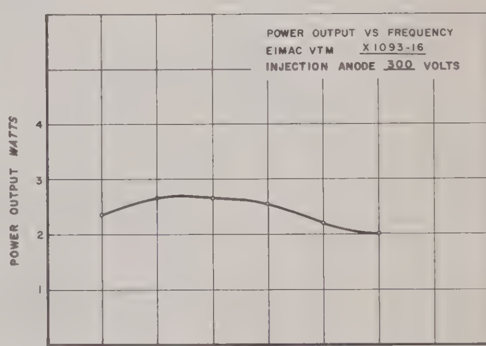
Vibration	10 G-(to 2kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

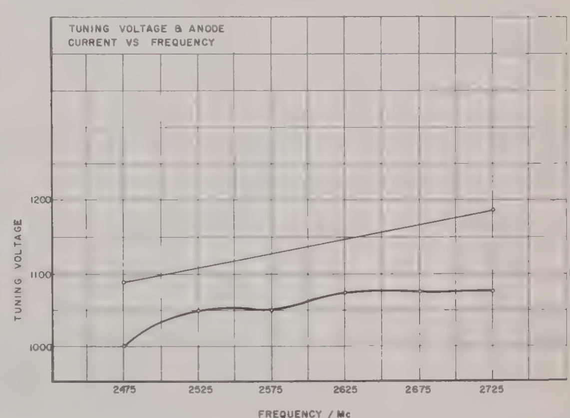
Height	3 inches
Width	2.1 inches
Length	4.5 inches



S-BAND OSCILLATOR



FREQUENCY MC	2475	2525	2575	2625	2675	2725
ANODE VOLTAGE	1080	1100	1120	1140	1160	1180
ANODE CURRENT MA	12.0	13.0	13.0	13.5	13.5	13.5



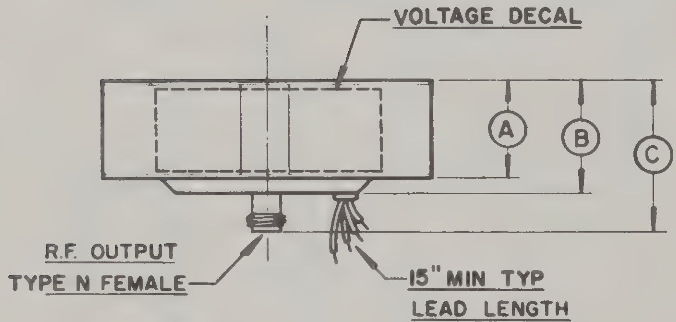
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

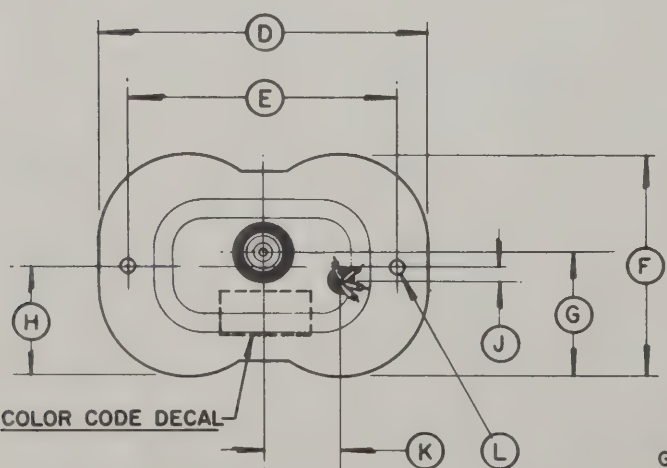
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the EM-1093 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM-1093 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 2600 megacycles, the temperature/frequency coefficient is typically 520 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.172
D		4.600	
E	3.640	3.671	
F		3.100	3.000
G			1.656
H			1.500
J			.375
K			1.000
L			.187 D.



CONNECTIONS
GROUND - GREEN
HEATER - WHITE
HEATER CATHODE - BLACK
INJECTION ANODE - YELLOW

Eimac

EITEL-McCULLOUGH, INC.

X-1087

VOLTAGE TUNABLE MAGNETRON

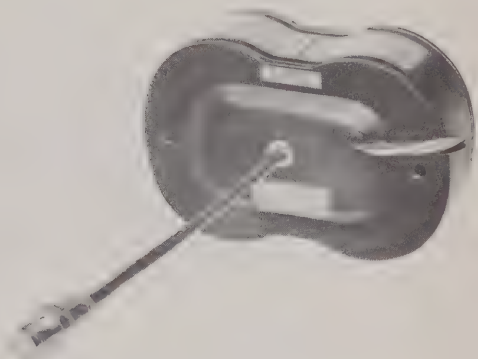
FREQUENCY
515-605 Mc

MINIMUM POWER OUTPUT
10 WATTS

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	515	605	Mc
Anode Voltage	1480	1790	V
Cathode Current	13	15	mA
Typical Output Power		10	W
Anode FM Sensitivity		0.3	Mc/V
Injection Anode Voltage		500	V
Injection Anode Current		0.1	mA
Heater Voltage (AC)		6.3	V
Heater Current (AC)		0.8	A
Load Impedance		50	ohms
Service			cw



P-BAND
OSCILLATOR

*MAXIMUM RATINGS

Anode Voltage	2500	V
Cathode Current	25	mA
Injection Anode Voltage	+700	V
Injection Anode Current	1	mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical	Flexible Leads
RF Output Coupling	Type TNC Female
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10 G-(to 2 kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

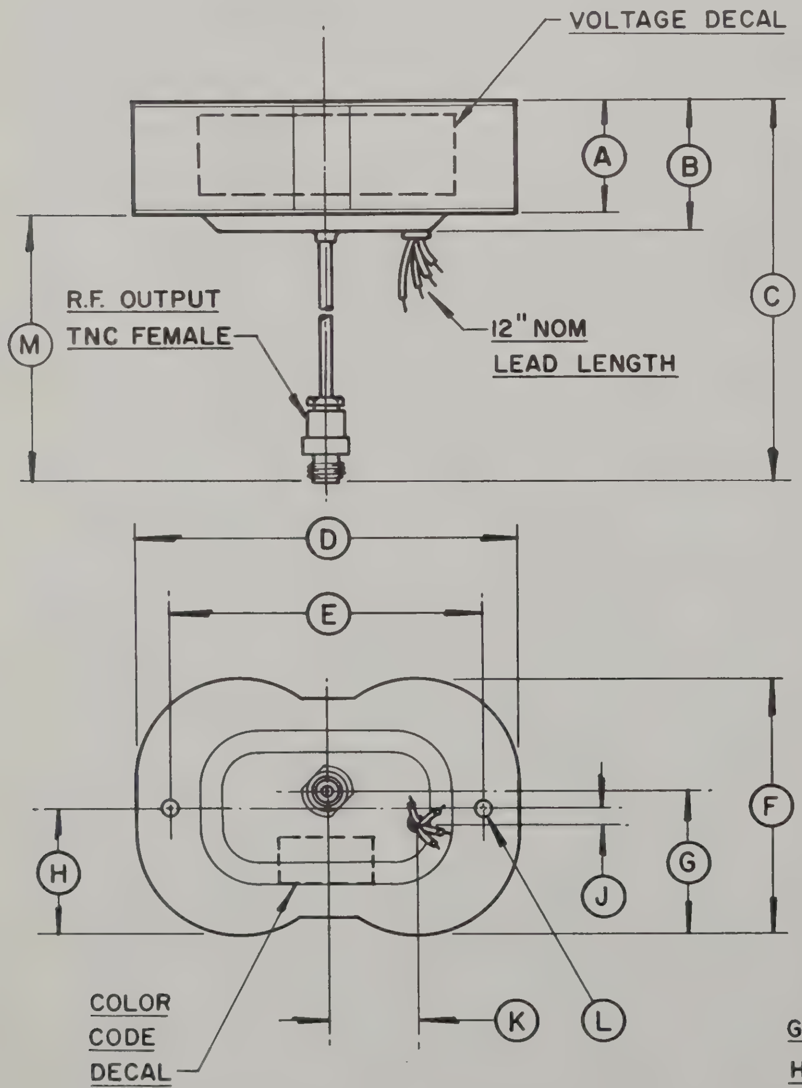
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1087 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficent for the X-1087 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 600 megacycles, the temperature/frequency coefficient is typically 120 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			9.375
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.
M			8"

CONNECTIONS

GROUND - GREEN

HEATER – WHITE

HEATER CATHODE – BLACK

INJECTION ANODE – YELLOW

Eimac®

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X1097

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 600-1200 Mc

MINIMUM OUTPUT POWER 5 WATTS

TYPICAL PERFORMANCE

L-BAND OSCILLATOR

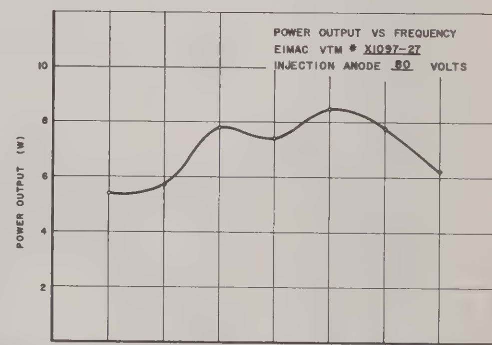
ELECTRICAL

Frequency Range	600-1200 Mc
Anode Voltage	1250-2450 V
Cathode Current	9-25 mA
Typical Output Power	5.5 watts
Anode FM Sensitivity	0.48 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	3000 V
Cathode Current	35 mA
Injection Anode Voltage	+500 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.



FREQUENCY MC	600	700	800	900	1000	1100	1200
ANODE VOLTAGE	1250	1470	1680	1900	2100	2260	2450
ANODE CURRENT MA	9.5	11	14	16	18	21	25

MECHANICAL

Operating Position	Any
Cooling	Forced Air
Electrical Connection	Flexible Leads
RF Output Coupling	TNC Jack
Weight	1.5 Pounds

ENVIRONMENTAL

Vibration	10 G-(to 2kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	2 inches
Width	1-1/4 inches
Length	3.5 inches

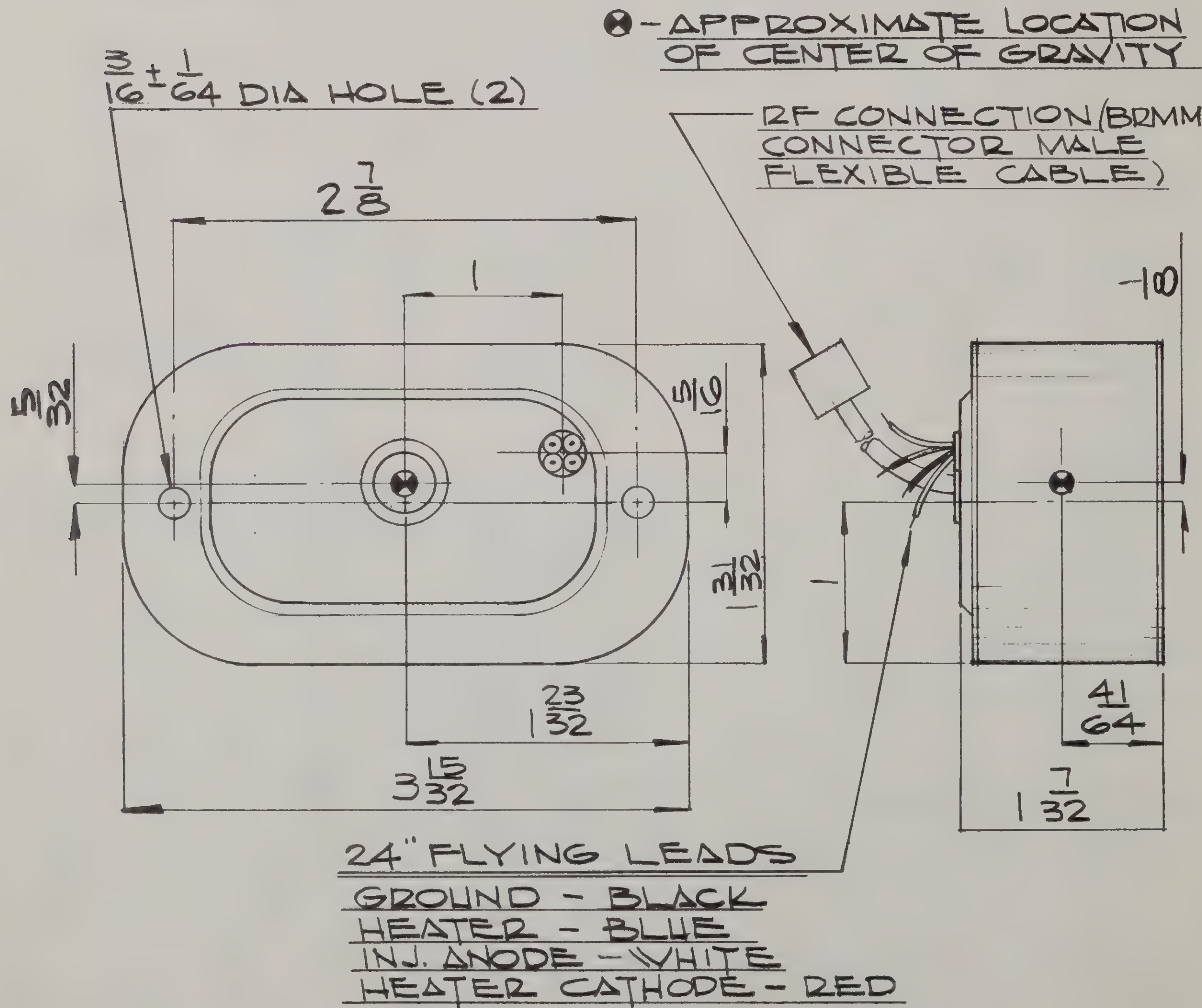
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. This tube was designed for operation in missile environments and can be operated for short periods of time without any cooling.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



NOTE: FRACTIONAL TOLERANCE ± 1/32 UNLESS OTHEWISE SPECIFIED

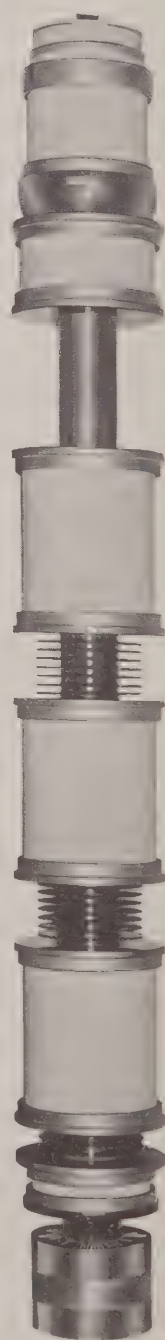
Eimac

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

3KM3LB

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 3KM3LB is a three-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 350 and 475 megacycles. This klystron will deliver a narrow-band CW output power of 2 kilowatts with a minimum power gain of 23 decibels. When adjusted for wide-band operation the 3KM3LB will deliver an output power of one kilowatt with a half-power bandwidth of 3 megacycles and a power gain of 20 decibels.

This klystron can be pulsed or amplitude modulated with minimum power by utilizing its modulating anode. Effective protection against internal arcs is provided by connecting the modulating anode to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-157 has been designed for use with the 3KM3LB to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load coupler, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - - - - - - - - -	7.5	volts
	Current - - - - - - - - - -	31.0	amperes
	Maximum Starting Current - -	62.0	amperes
	Nominal Cold Resistance - - -	0.02	ohms
Cathode:	Unipotential, Oxide Coated		
	Heating Time - - - - - - - -	5	minutes
Power Gain: (Narrow Band) - - - - - -		30	decibels
Output Power: (Narrow Band) - - - - - -		2	kilowatts
Frequency Range (H-157 Assembly) -		350 to 475	megacycles

MECHANICAL

Operating Position - - - - - - - Axis vertical, cathode up

RF Coupling:

- Input - - - - - - - - Type "N" coaxial fitting
- Output - - - - - - - 1-5/8 inch, 50-ohm line
- Cavity Loading
  - (Input and 2nd) - - - Type "N" coaxial fitting
  - (Supplied at customers option)

MECHANICAL (continued)

Weights:

3KM3LB Klystron only	46 lbs (Net), 130 lbs (Gross)
H-157 RF Circuit Assembly	570 lbs (Net), 798 lbs (Gross)
Cooling	Forced air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*5 cfm	0.4 inch H_2O
Output Cavity	*50 cfm	1.0 inch H_2O
Klystron Collector	*200 cfm	1.5 inches H_2O

FOCUS-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil: Voltage	0 to 25	volts
Current	0 to 1.25	amperes
Each of Two Body Coils: Voltage	0 to 175	volts
Current	0 to 3.0	amperes
Collector-Coil Voltage	0 to 50	volts
Collector-Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

BEAM VOLTAGE	9	KILOVOLTS
BEAM CURRENT	750	MILLIAMPERES
BODY CURRENT (CONTINUOUS)	75	MILLIAMPERES
BODY CURRENT (TUNING ONLY)	100	MILLIAMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	3	KILOWATTS

TYPICAL OPERATION

	Narrow Band		Wide Band	
Frequency	350	475	350	megacycles
Output Power	2.4	2.3	1	kilowatts
Driving Power	10	10	10	watts
Power Gain	23.8	23.6	20	decibels
Beam Voltage	9	9	8	kilovolts
Beam Current	590	590	540	milliamperes
Beam Power Efficiency	45.2	43.4	23.3	percent
Body Current	30	40	30	milliamperes
Focus-Electrode Voltage	-200	-200	-135	volts
Half-Power Bandwidth	0.7	0.9	3	megacycles
Cavity Loading:				
1st Cavity	---	---	9	watts
2nd Cavity	---	---	25	watts
Focus-Coil Currents:				
Prefocus	0.7	0.7	0.7	ampere
First Body	2	2	2	amperes
Second Body	1.3	1.3	1	amperes
Collector	1	1	1	ampere

* At sea level with 20° C inlet air temperature.

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.

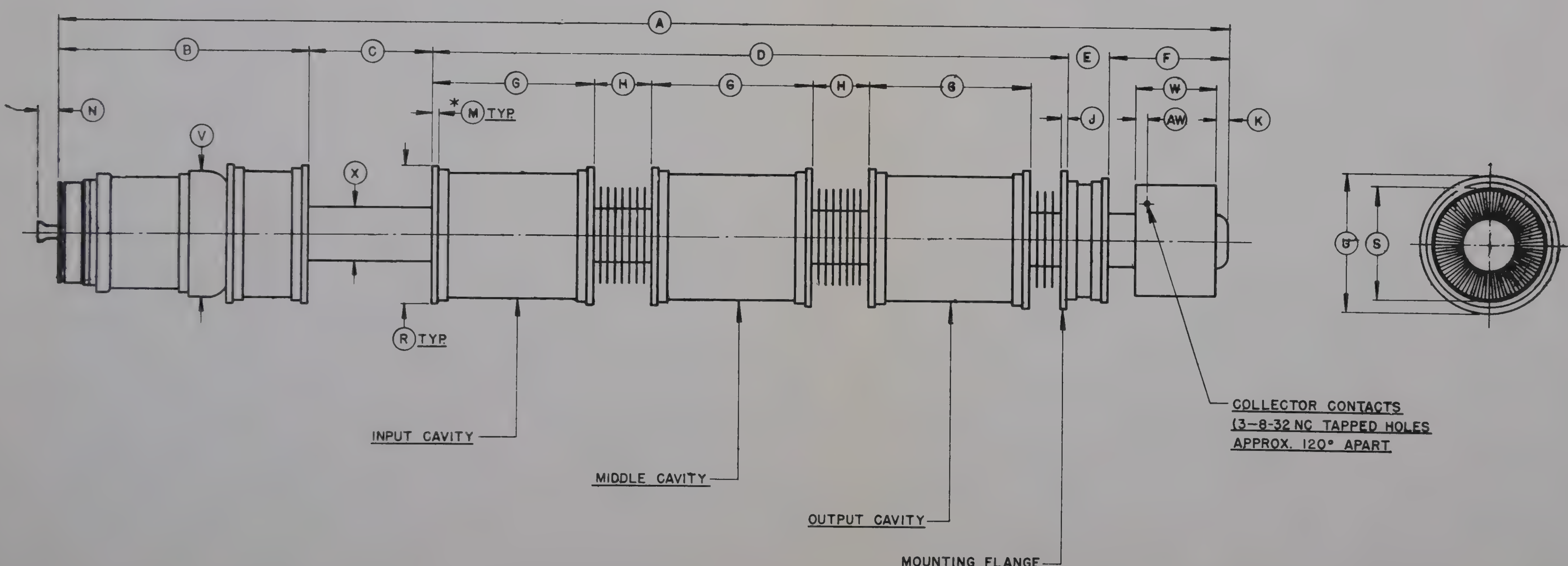
3KM3LB Eimac

DIMENSION DATA

REF.	NOM.	MIN.	MAX.
A		42.895	43.485
B		9.125	9.330
C		4.460	4.520
D		23.600	23.700
E		1.480	1.540
F		4.340	4.450
G		5.995	6.030
H		2.085	2.155
J		.235	.260
K			.435
M		.187	.260
N			1.500
R		5.118	5.132
S		4.110	4.140
U		5.118	5.132
V		4.615	4.650
W		2.950	3.125
X		1.990	2.010
AW		.340	.505

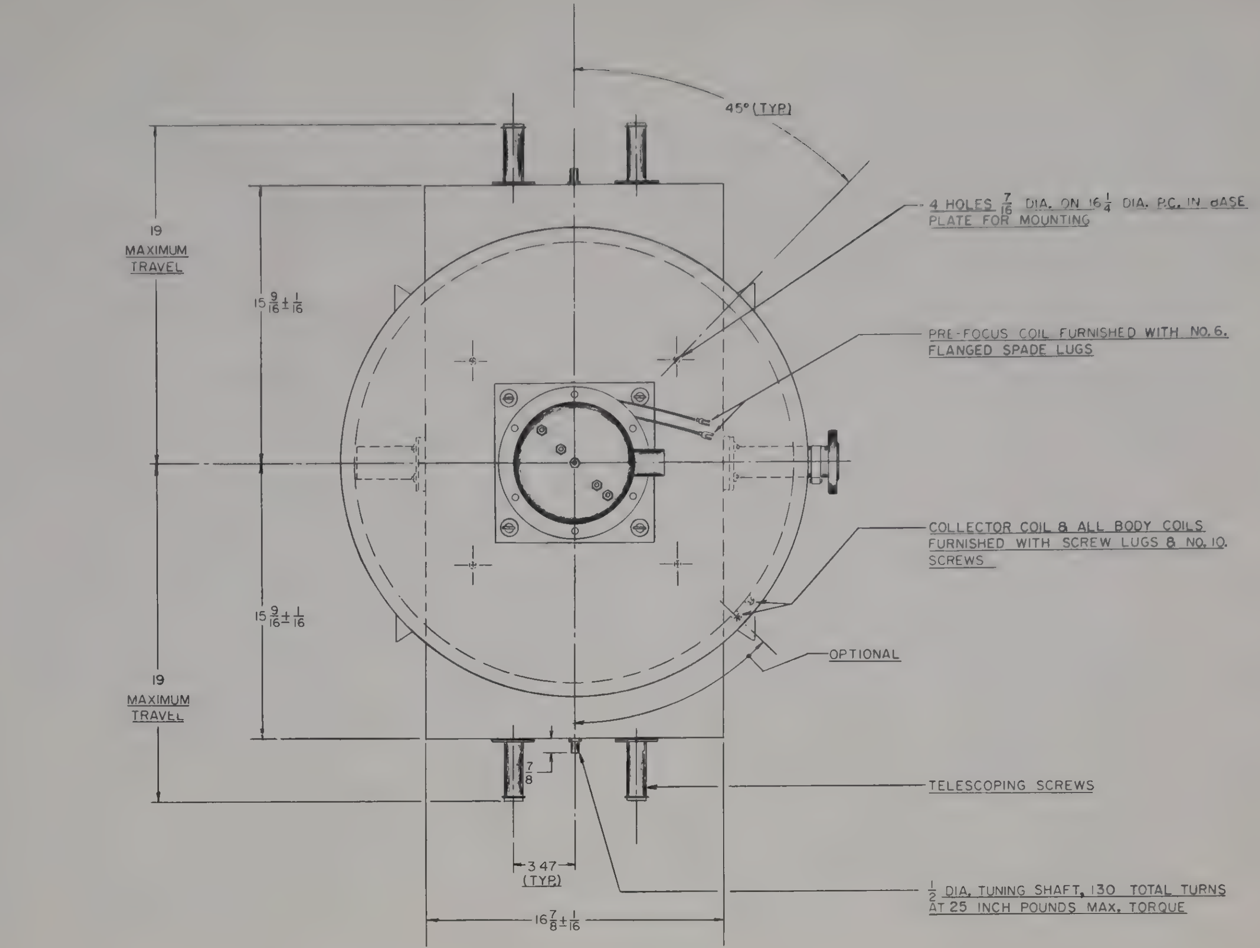
NOTES:

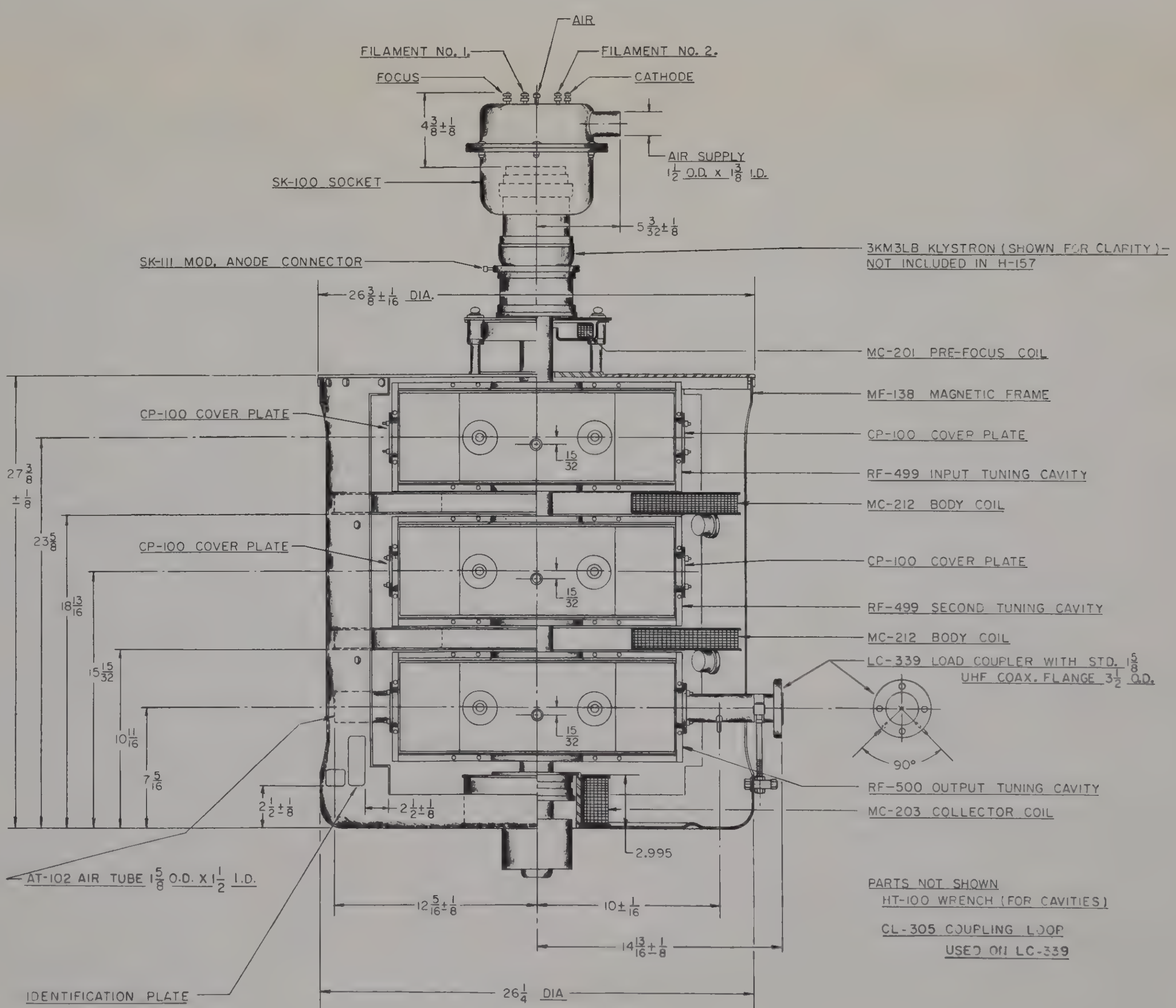
1. DIMENSIONS IN INCHES.
2. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE OUTLINE GUN NO. 1-6001
3. * MINIMUM CONTACT SURFACES



3KM3LB KLYSTRON

Eimac 3KM3LB





H-157 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EITEL-McCULLOUGH, INC.

TENTATIVE DATA

X-1098

VOLTAGE TUNABLE MAGNETRON

FREQUENCY
885-1460 Mc

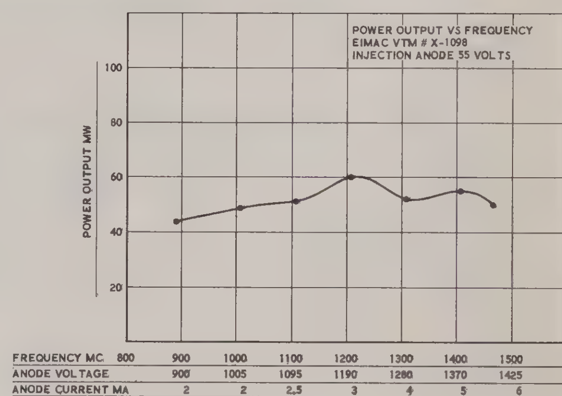
MINIMUM OUTPUT POWER
32 mW

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	885-1460 kMc
Anode Voltage	900-1420 V
Cathode Current	2-6 mA
Typical Output Power	45-80 mW
Anode FM Sensitivity	1.1 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw

LOW NOISE L-BAND OSCILLATOR



*MAXIMUM RATINGS

Anode Voltage	1800 V
Cathode Current	20 mA
Injection Anode Voltage	300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10 G-(to 2 kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

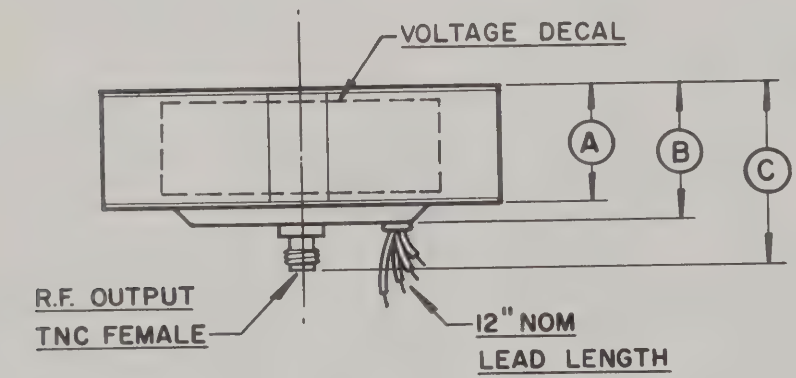
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

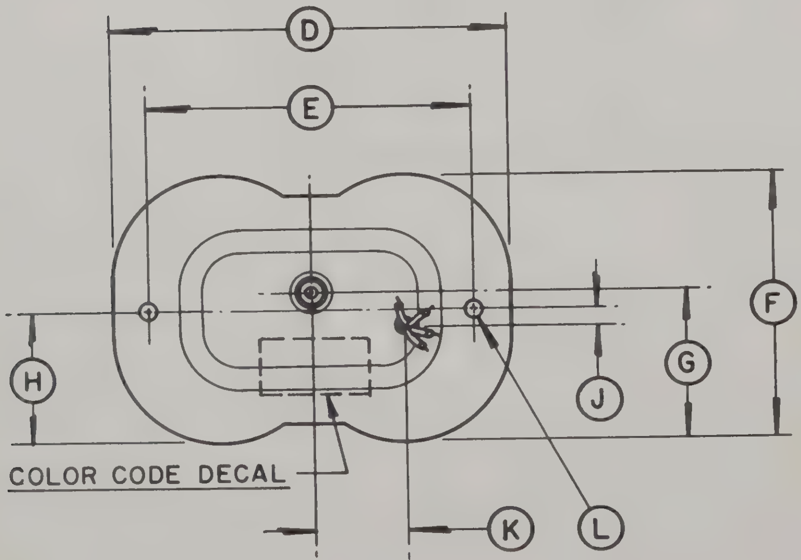
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1098 has been temperature stabilized to minimize frequency changes caused by variations in the ambiént temperature. The temperature/frequency coefficient for the X-1098 package is typically .006% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1450 megacycles, the temperature/frequency coefficient is typically 300 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

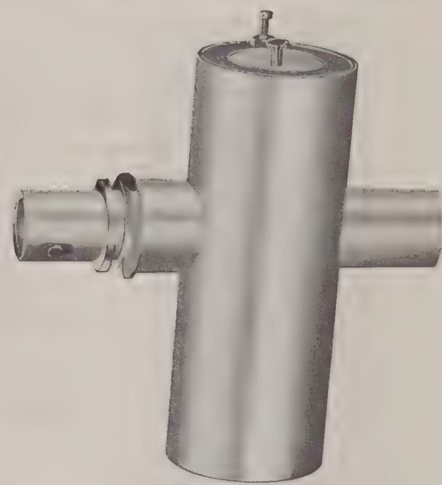
EITEL-McCULLOUGH, INC.

EM4543

CAVITY OSCILLATOR

1700-1850 Mc

The Eimac EM4543 is an ultra-stable low noise cavity oscillator designed for use in microwave transmitters where compactness and ruggedness is required. Excellent frequency stability over a wide temperature range is a major advantage of this oscillator. It incorporates the Eimac 128613 ceramic-metal planar triode. Operating life, without tube change, is over 5000 hours average.



CHARACTERISTICS

ELECTRICAL

Tuning Range		1700-1850* Mc
rf Power Output		1.6** Watts CW
Frequency Stability		±0.15% from —40°C to +75°C
Power Supply Requirements:	Voltage	Current
Anode, Maximum	140 V	50 mA
Control Grid, Maximum		Self Bias
Heater	6.0 V	400 mA
Tube Type		Eimac 128613
Load Impedance		50 ohms nominal
Modulation		CW
VSWR, maximum		1.3:1, any phase
rf Noise, maximum		0.2 percent

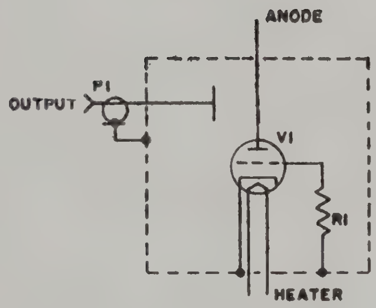
MECHANICAL

Mounting	Clamps to heat sink cradle
Size	Length: 2.25 inches Diameter: 0.85 inches
Weight	0.25 pounds
Cooling	Conduction
Connector	Type TNC Female

ENVIRONMENTAL

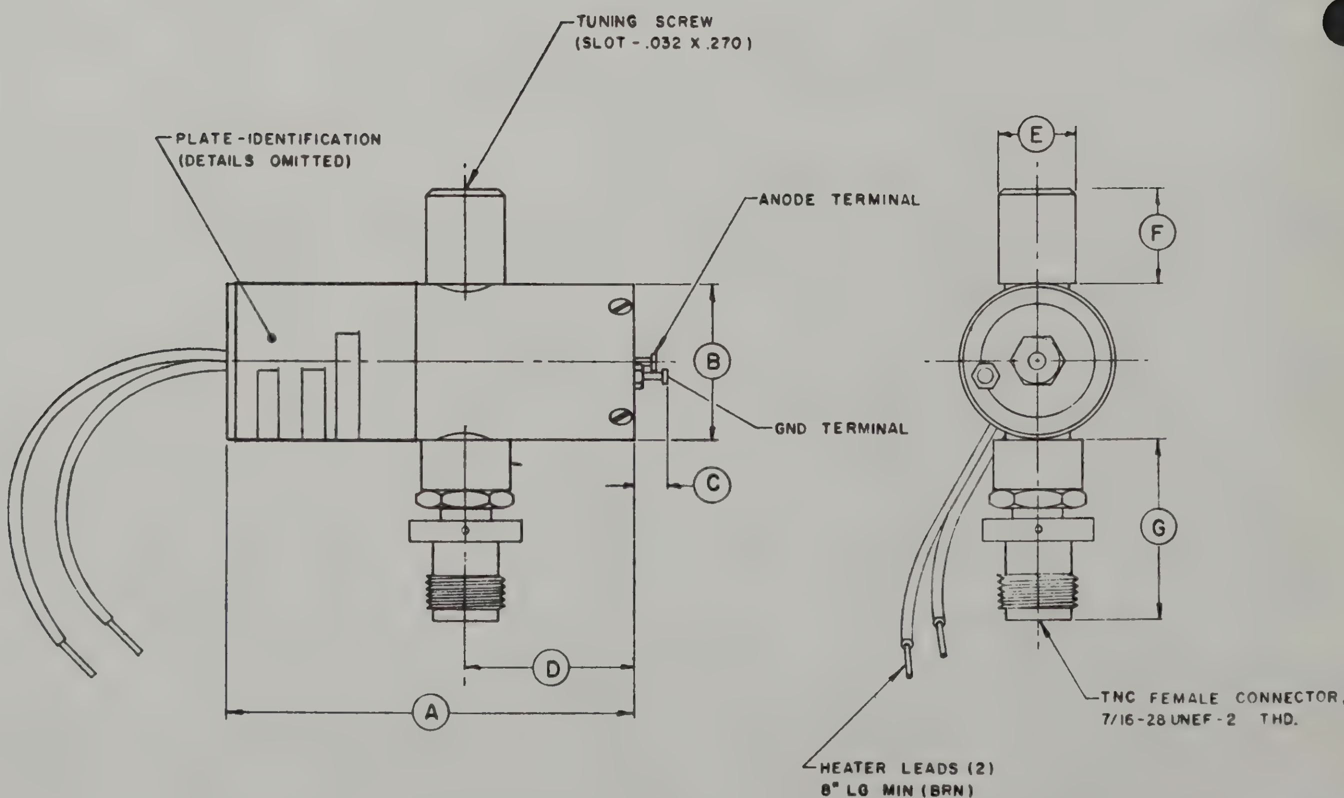
Temperature	—40°C to +75°C
Altitude	0 to 12,000 feet

*Factory adjusted for any 48 Mc Segment of the 1700-1850 Mc band.
**Can provide up to 3 watts output with higher anode voltage and current and special cooling.



SCHEMATIC

DIMENSIONAL DATA			
REF	MAX	MIN	NOM
A	2.300	2.255	
B	.860 DIA	.850 DIA	
C	—	—	.181
D	.973	.930	
E	.437 DIA	.429 DIA	
F	.535	.525	
G	1.000	.935	

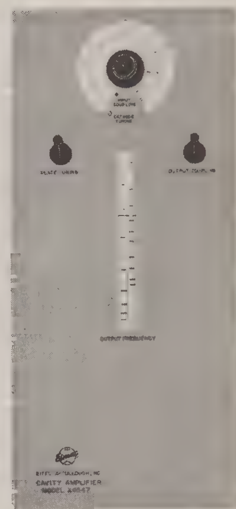


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4547

CAVITY AMPLIFIER

150-1000 Mc
100 WATTS CW



This is a broad-tuning cavity amplifier, incorporating the Eimac X843D ceramic-metal planar triode. It is intended for use in test equipment consoles and special transmitters. High power output and wide tuning range are outstanding features of this amplifier.

A recommended driver for use with this amplifier is Eimac EM4555 oscillator.

CHARACTERISTICS

ELECTRICAL

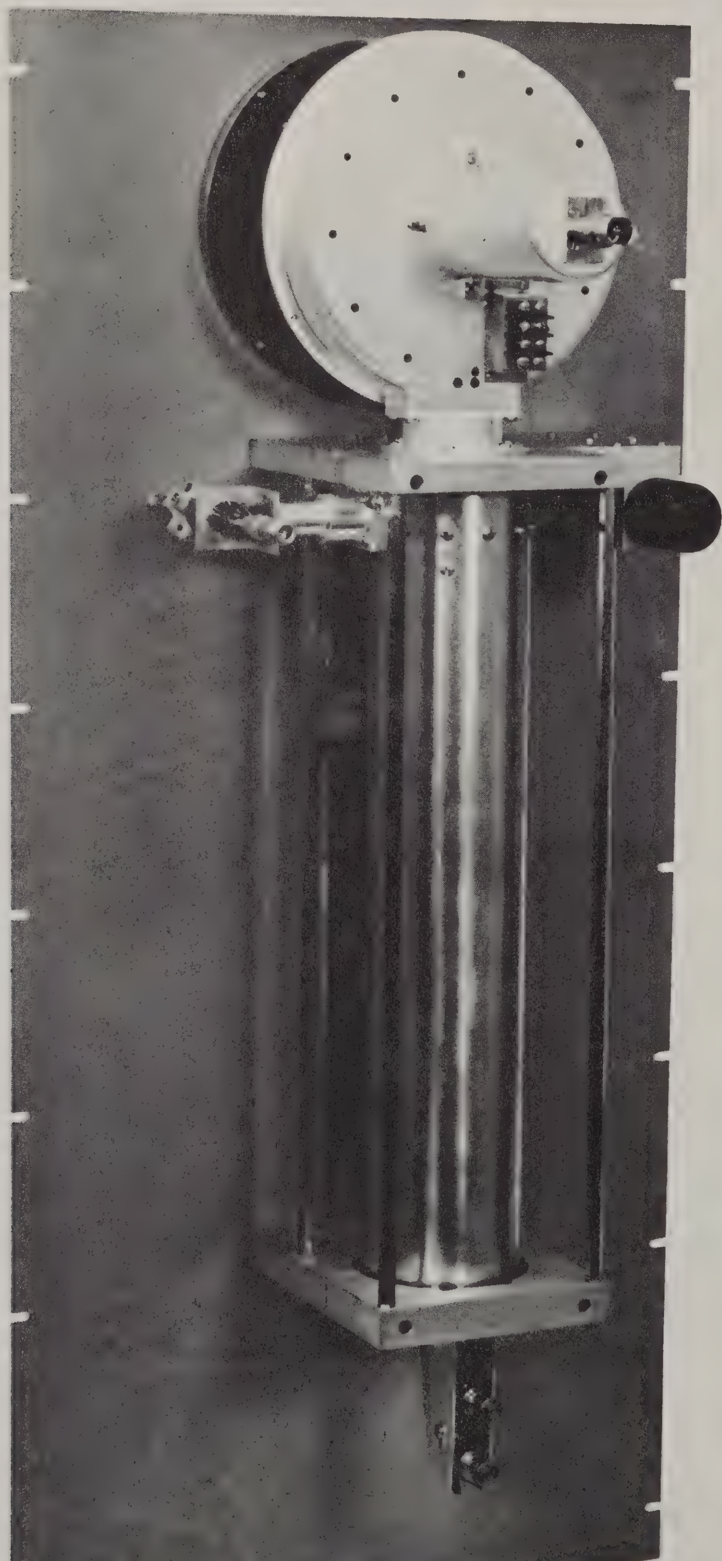
Tuning Range	150-1000 Mc	
Tube Type	Eimac X843D	
Power Supply Requirements:		
Anode Voltage	1000	V
Current	250	mA
Heater Voltage	5.5	V
Current	2.7	A
Grid Current, Maximum	100	mA
Cathode Current, Maximum	300	mA
Operating Characteristics:		
rf Drive Power Required (nominal)	10	W
Power Output, minimum	100	W
Bandwidth, 3 db points	5	Mc
Load Impedance	50 ohms nominal	
Load VSWR, Maximum	1.5:1	Any Phase
Gain, Minimum	10	db

MECHANICAL

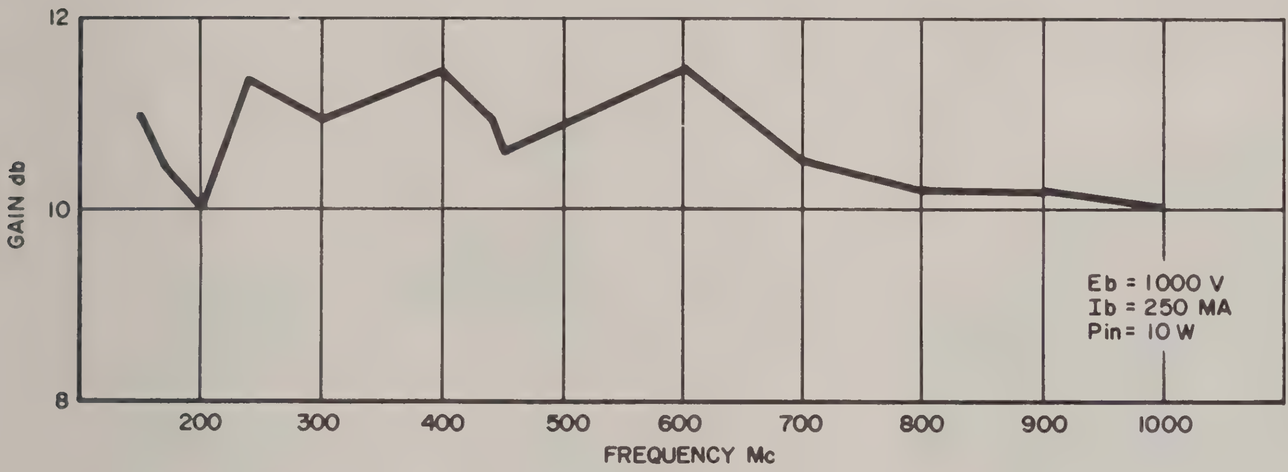
Connectors	Type N Female
Cooling	Liquid (self-contained)
Maximum Overall Dimensions	11"x 19"x 55"
Net Weight	50 pounds
Mounting	19" Relay Rack

ENVIRONMENTAL

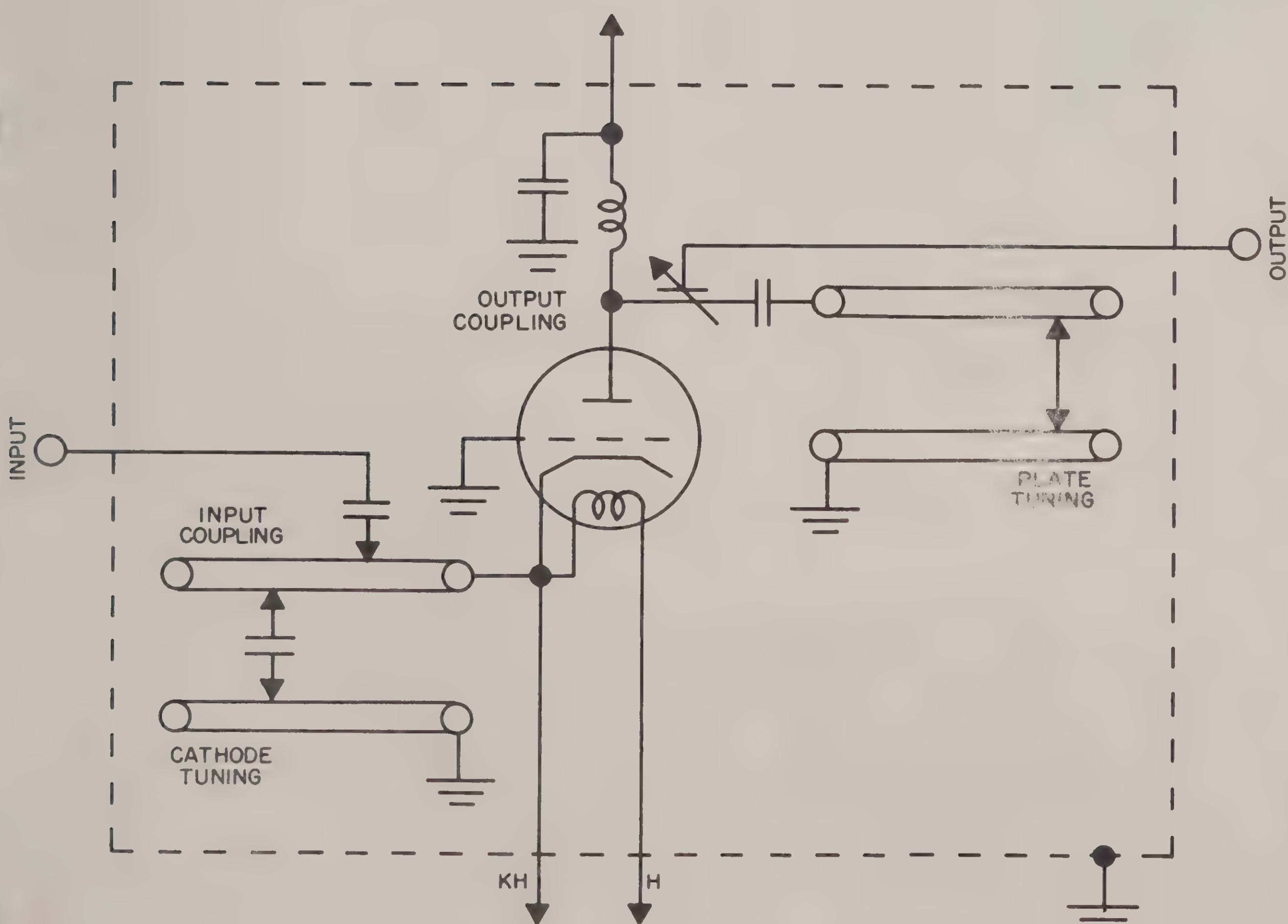
Operating Temperature	—10 to +50°C
Altitude	0 to 12,000 feet



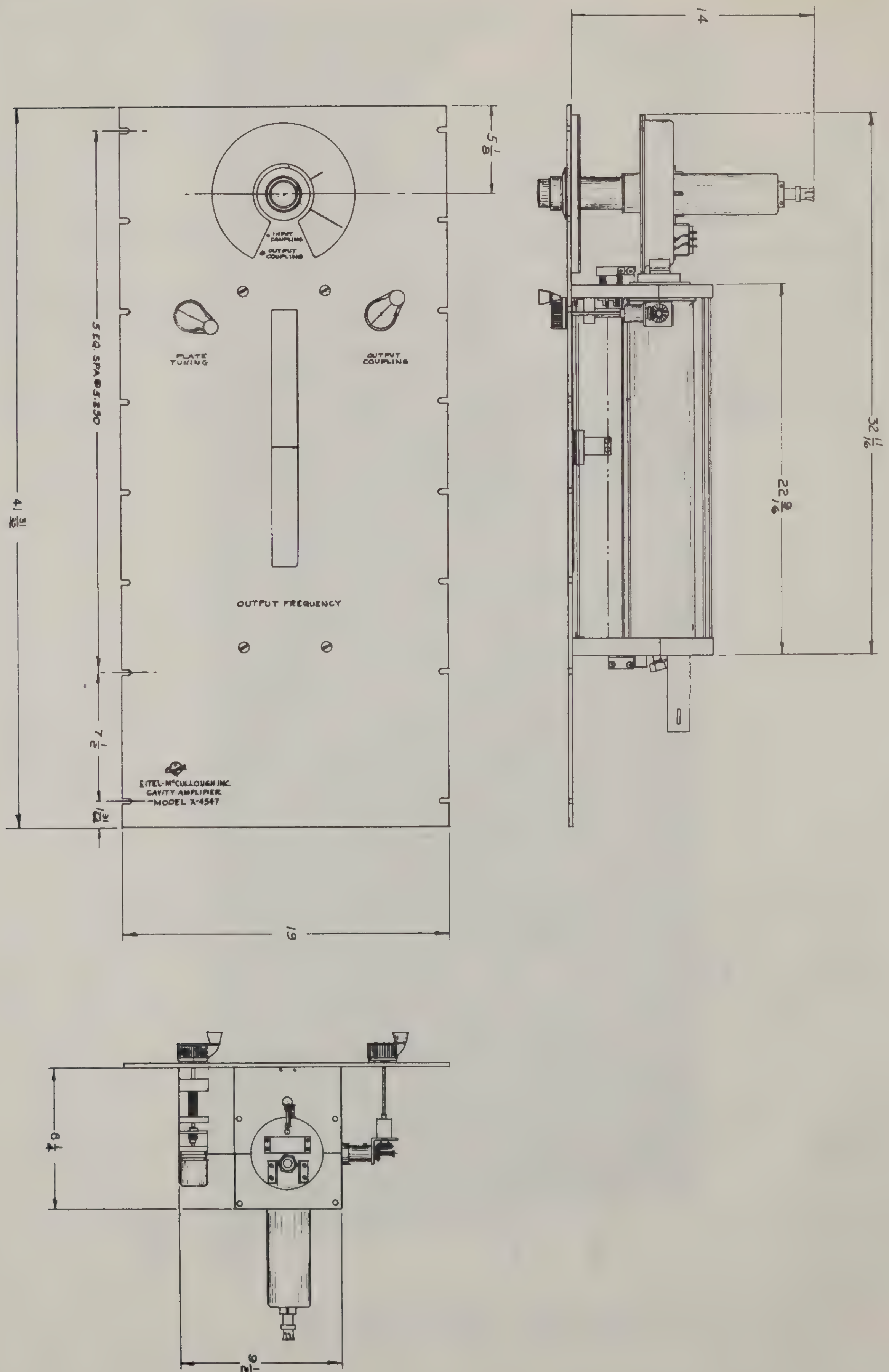
REAR VIEW, EM4547 AMPLIFIER



GAIN OF EM 4547 AMPLIFIER



SCHEMATIC, EM 4547 AMPLIFIER

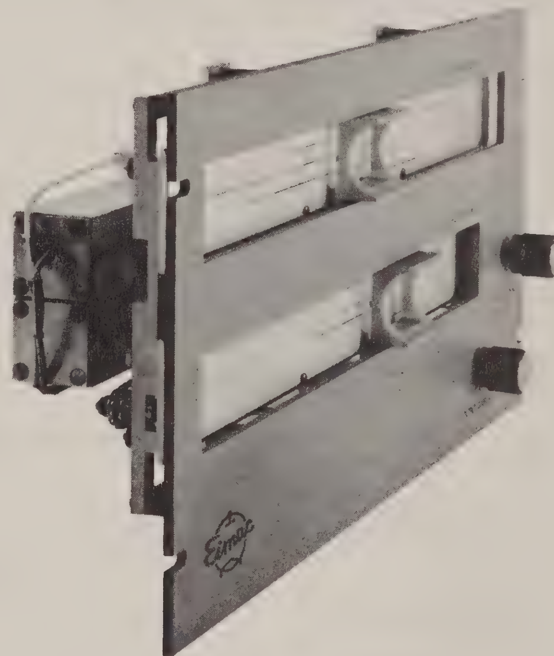

INPUT COUPLING
OUTPUT COUPLING
PLATE TUNING
OUTPUT COUPLING
OUTPUT FREQUENCY
EITEL-McCULLOUGH INC.
CAVITY AMPLIFIER
MODEL X-4547
5 EQ. SPA@5.250
19
14

Eimac®

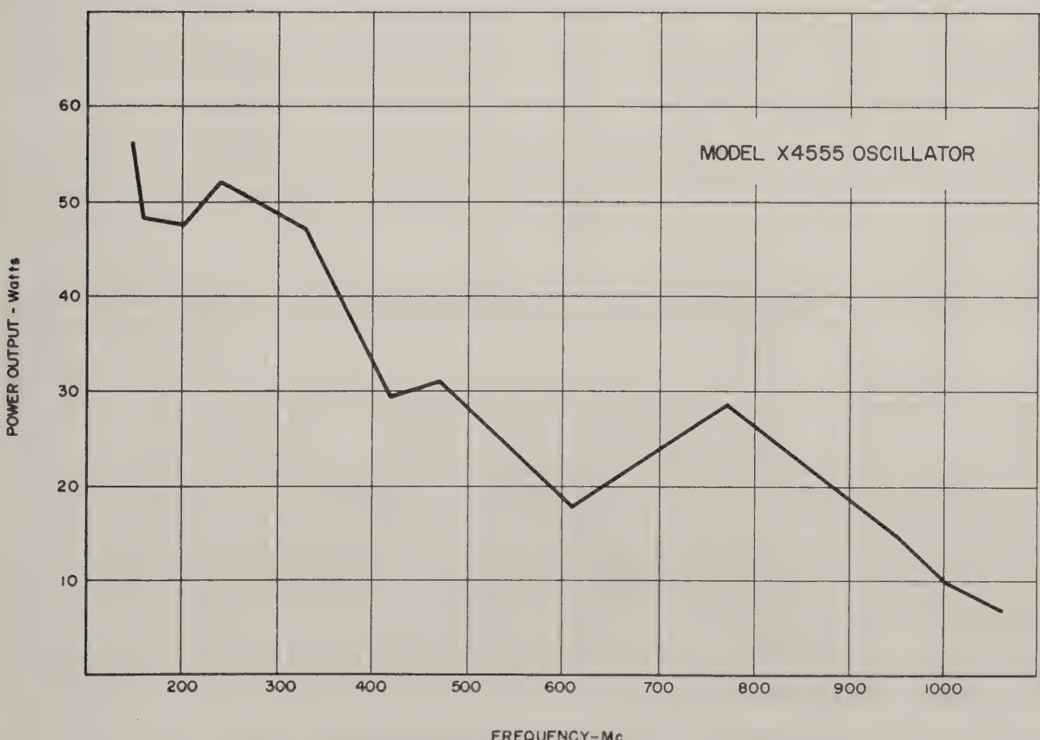
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM4555

BROAD TUNING OSCILLATOR 150-1050 Mc



The Eimac EM4555 is a broad-tuning cavity power oscillator incorporating the Eimac Y-319 ceramic-metal planar triode. It is intended for use in test equipment consoles and special transmitters. This oscillator has front-panel tuning knobs and frequency scales for tuning across the 150-1050 Mc band with power output from 40 to 5 watts.



CHARACTERISTICS

ELECTRICAL

Frequency, continuously tunable		150-1050 Mc
RF Power Output	Frequency, Mc	Power output, watts, CW
	150- 300	40
	300- 500	20
	500- 900	15
	900-1050	5
Frequency Drift,[1] percent of operating frequency		±0.05%
Power Supply Requirements:	Voltage	Current
Anode, maximum	1 KV	100 mA
Grid Current, maximum		50 mA
Heater	6.0 V	1 A
Ground		Positive terminal of anode supply
Cathode Current, maximum		125 mA
Tube Type		Eimac Y-319
Load Impedance		50 ohms nominal
Load VSWR, maximum		2.0:1 any phase, without damage

MECHANICAL

Mounting	Standard 19" relay rack
Size	height — 8¾ inches depth — 4½ inches
Weight	10 pounds
Operating Controls	Tuning knobs and frequency scales provided[2]
Cooling	Conduction — Convection[3]
Connector	Rear Mounted Type TNC Female

ENVIRONMENTAL

Temperature	—10 to +50°C (+14 to +122°F)[3]
Altitude	0 to 12,000 feet

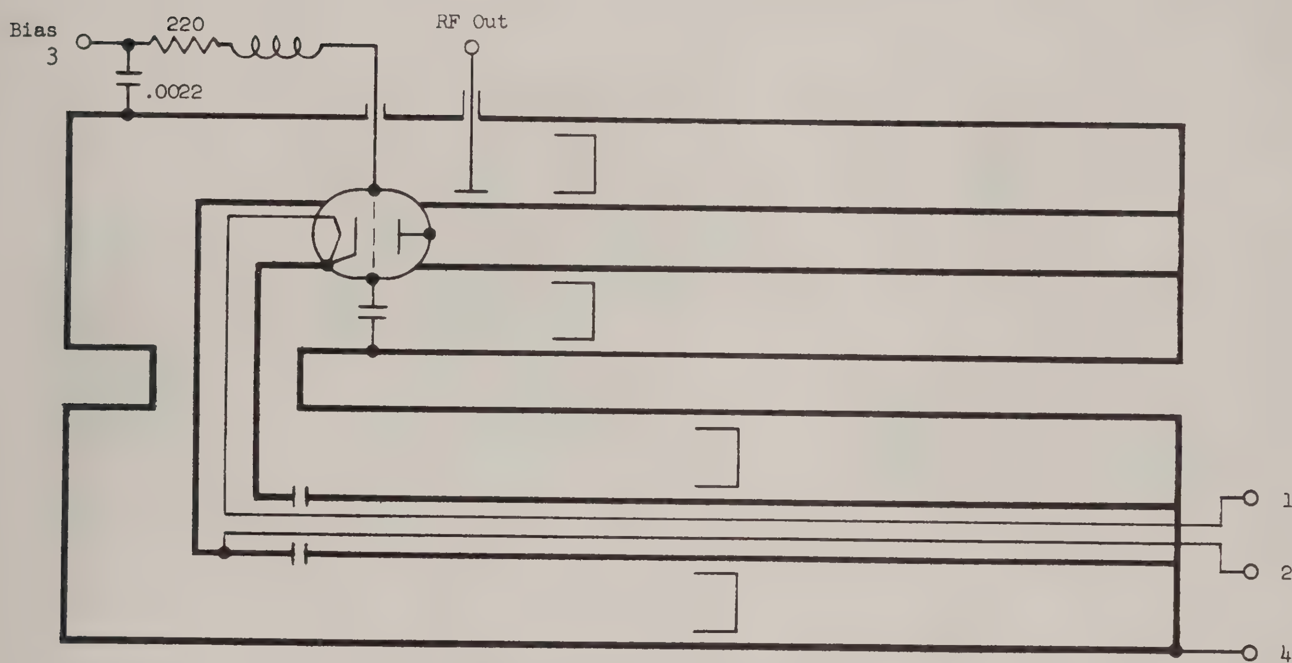
NOTES:

(1) Frequency drift is specified over a period of 2 hours, following a warm-up period of ½ hour minimum.

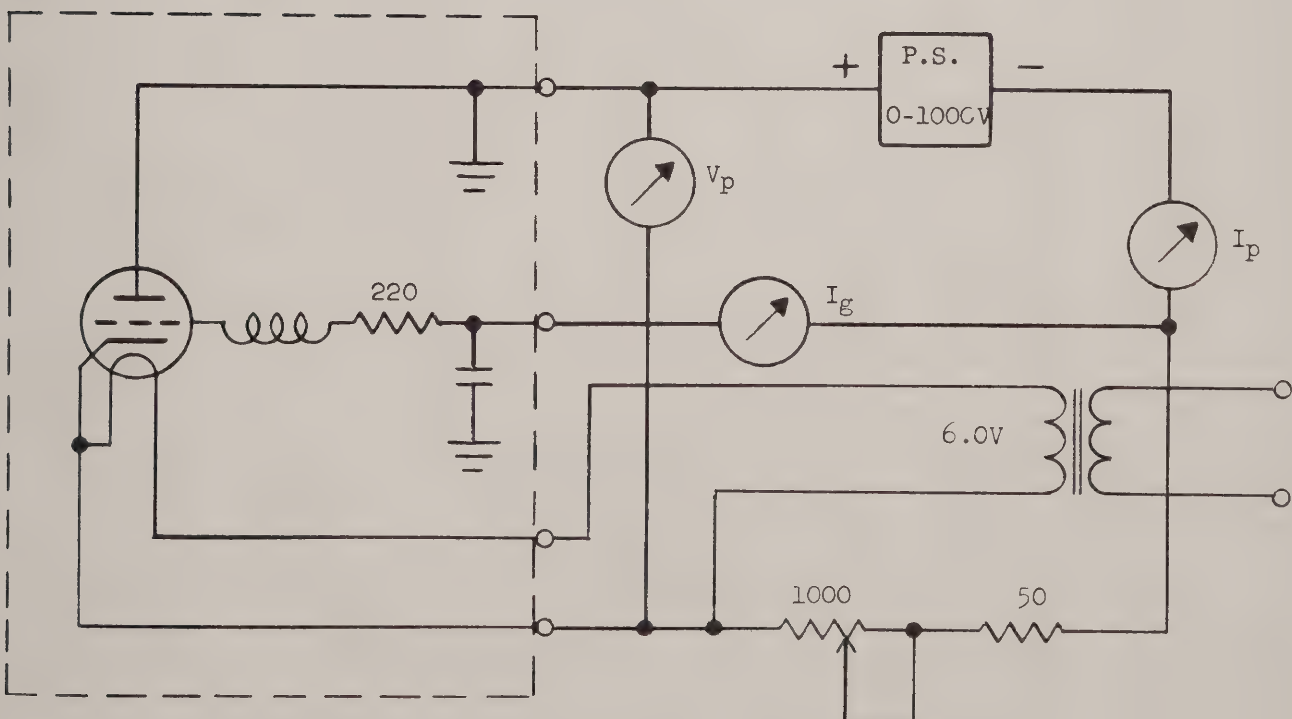
(2) Knobs are provided on the front panel for fine tuning the plate and cathode cavities and for adjusting output coupling. Direct-reading frequency scales are provided for each cavity. Tuning is accomplished by sliding the hairline windows to the desired frequency, then adjusting the fine tuning and output coupling. Access to the interior of the amplifier is not required for tuning.

(3) If ambient temperature exceeds 90°F, the cavity body will become quite hot (up to 250°F), and forced air cooling is recommended.

For personnel protection, high voltage circuits above 500 volts are enclosed and identified. Interlocks are not provided.

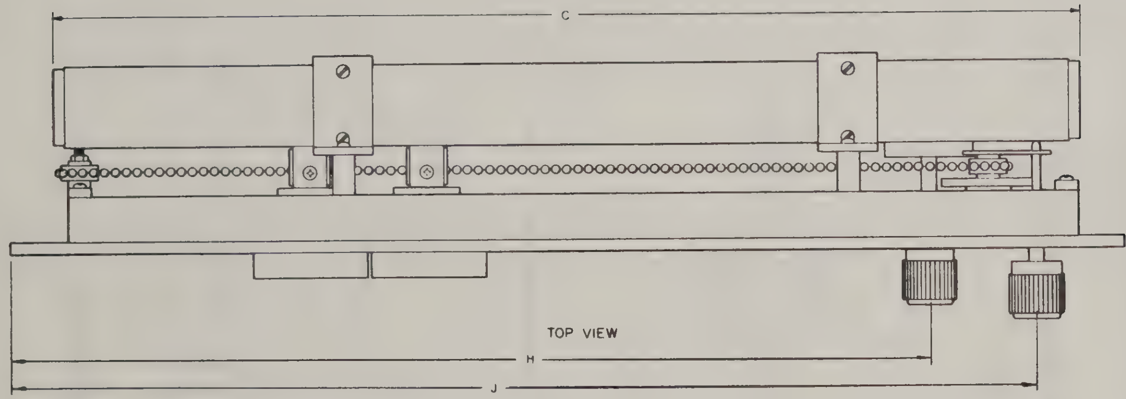


EM4555 CAVITY OSCILLATOR
Figure 2

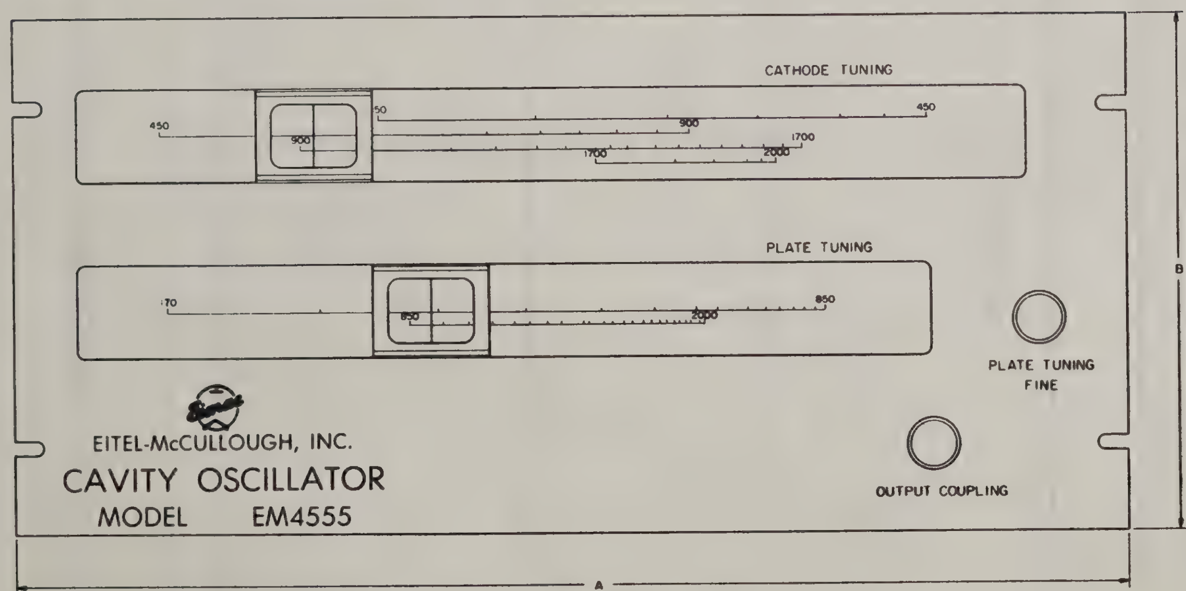


EM4555 POWER SUPPLY CONNECTIONS
Figure 3

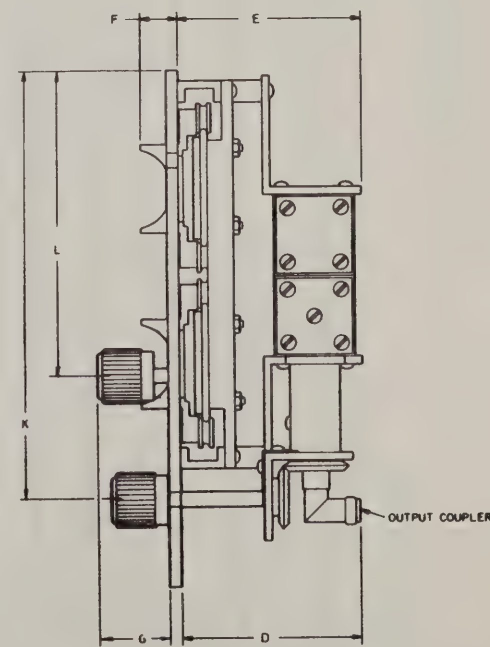
DIMENSION DATA		
REF	MIN	MAX
A	18.969	19.000
B	8.719	8.750
C	17.417	17.521
D	2.863	3.091
E	3.025	3.099
F	.589	.598
G	1.182	1.214
H	15.583	15.635
J	17.474	17.526
K	7.245	7.287
L	5.167	5.209



TOP VIEW



FRONT VIEW



SIDE VIEW

06890	EM4555
CODE IDENT	PART NO

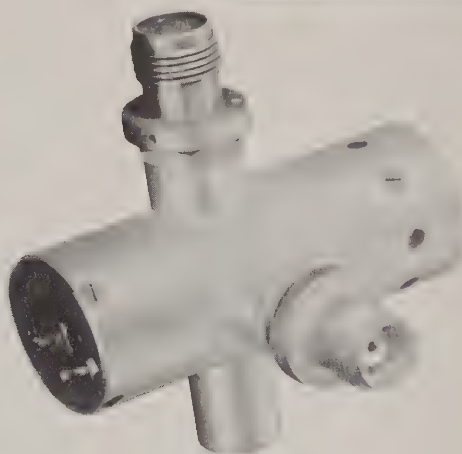
Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

EM4564
CAVITY
OSCILLATOR
1700-1850* Mc

The Eimac EM4564 is an ultra-stable low noise cavity oscillator designed for use in microwave transmitters where compactness and ruggedness is required. Excellent frequency stability over a wide temperature range is a major advantage of this oscillator. It incorporates the Eimac 128631 ceramic-metal planar triode. Operating life, without tube change, is over 5000 hours average.

A connector inlet port is provided in the plate cavity for insertion of a modulator.



CHARACTERISTICS

ELECTRICAL

Tuning Range	1700-1850* Mc
rf Power Output	1.6** Watts CW
Frequency Stability	±0.15% from —40°C to +75°C

Power Supply Requirements:	Voltage	Current
Anode, Maximum	140 V	50 mA
Control Grid, Maximum		Self Bias
Heater	6.0 V	400 mA

Tube Type	Eimac 128631
Load Impedance	50 ohms nominal
Modulation	CW
VSWR, maximum	1.3:1, any phase
rf Noise, maximum	0.2 percent

MECHANICAL

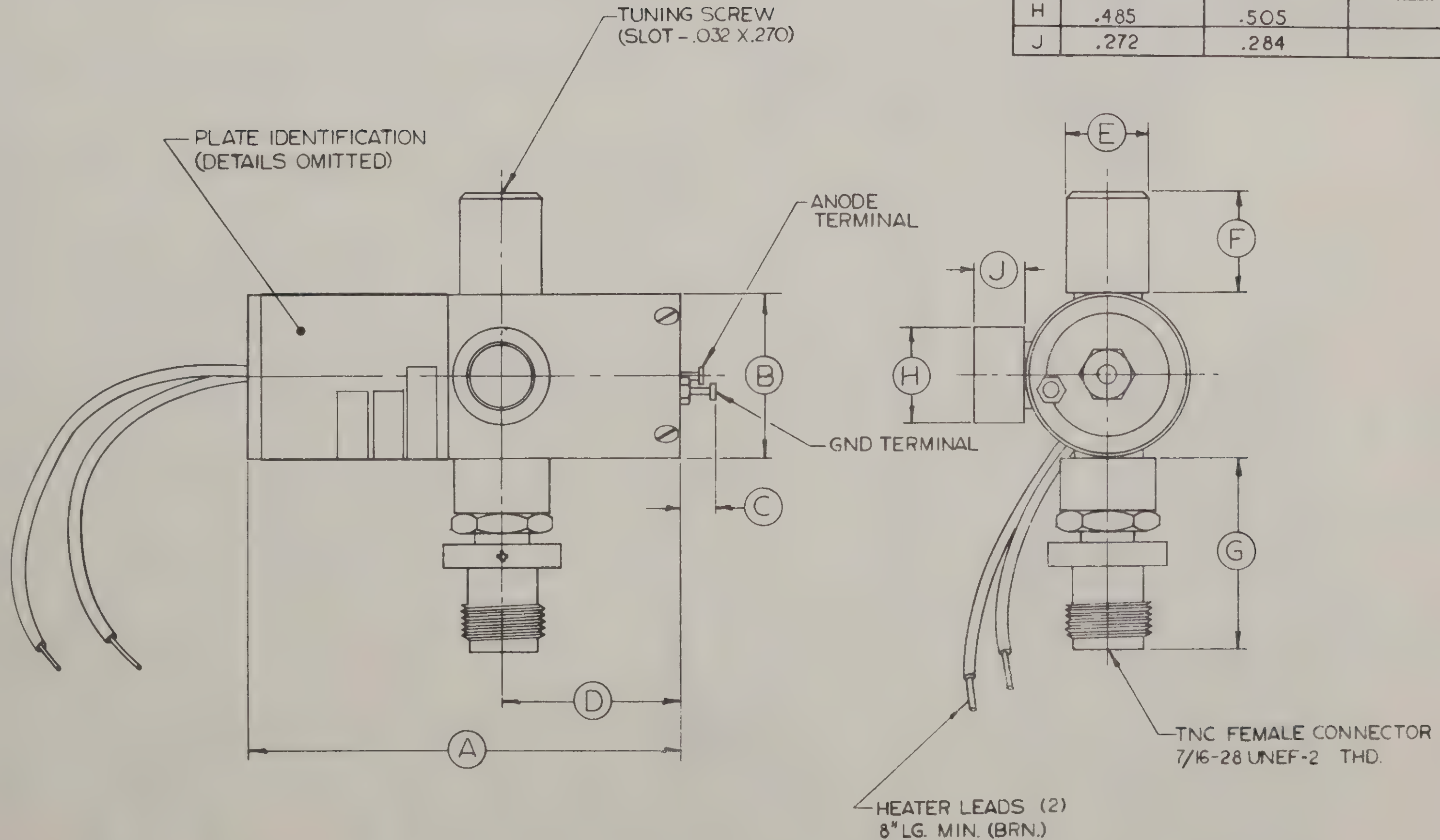
Mounting	Clamps to heat sink cradle
Size	Length: 2.25 inches Diameter: 0.85 inches
Weight	0.3 pounds
Cooling	Conduction
Connectors	Type TNC Female

ENVIRONMENTAL

Temperature	—40°C to +75°C
Altitude	0 to 12,000 feet

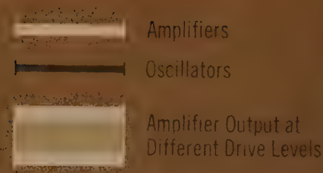
*Factory adjusted for any 48 Mc Segment of the 1700-1850 Mc band.
**Can provide up to 3 watts output with higher anode voltage and current and special cooling.

DIMENSIONAL DATA			
DIM	MIN	MAX	REF
A	2.255	2.300	
B	.850 DIA.	.860 DIA.	
C	—	—	.181
D	.930	.973	
E	.429 DIA.	.437 DIA.	
F	.525	.535	
G	1.000	.935	
H	.485	.505	
J	.272	.284	

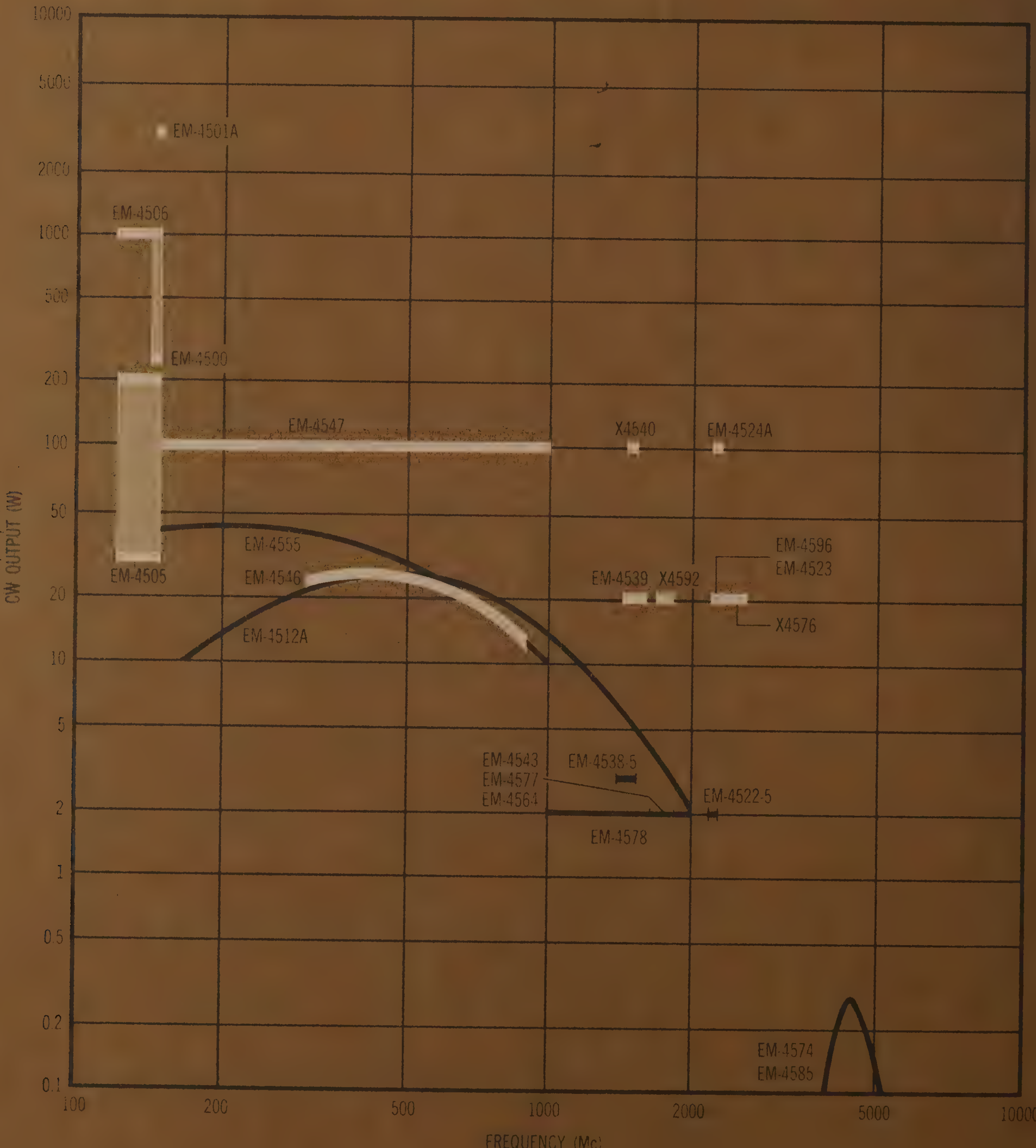


EIMAC R-F CAVITIES

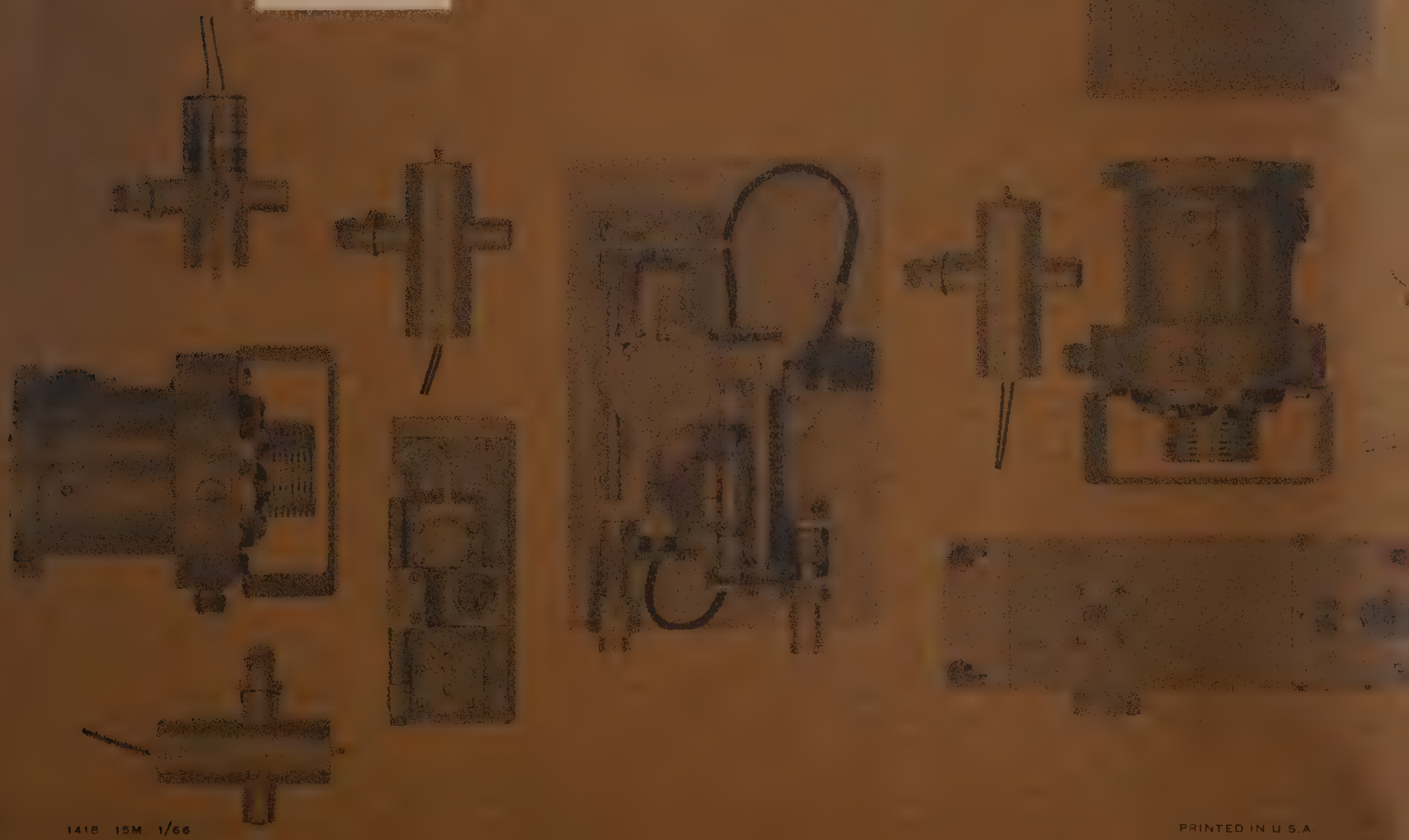
CW Amplifiers and Oscillators



EIMAC CW CAVITY OUTPUT CHARACTERISTICS



eimac
division of varian
301 industrial way / san carlos / california 94070
phone (415) 592-1221 / cable "eimac" san carlos



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PRINTED IN U.S.A.

UHF CAVITY AMPLIFIERS high power output

Eimac cavity amplifiers are compact, conduction-cooled packages for use in aerospace transmitters and as booster amplifiers for low-power transmitters. They are also suitable for use in transportable ground transmitters and other applications where small size, light weight, sturdy construction, and reliability are important. The electron tubes in these amplifiers are durable ceramic-metal planar triodes.

EM-4539 and EM-4596 amplifiers deliver 15–20 W for L-band and S-band telemetry transmitters. Each is hermetically sealed with all connectors and tuners on one side. Only three controls are needed to tune the entire range of each amplifier. Other features include: harmonic suppression of >60 db; bandwidth of >10 Mc; and peak phase jitter of $<5°$ with 20 G vibration from 20–2000 cps.

A similar amplifier, X4592, covers the 1700–1850 Mc range.

The EM-4590 power supply (dc-dc converter), which operates from a 28-Vdc source, is recommended for use with these amplifiers. Ac supplies can be supplied on special order.

The EM-4524A amplifier provides either 100 W output with 10 W drive, or 50 W output with 3 W drive. Its small size (25 cubic inches) and high efficiency make it ideal for use in high-power, S-band telemetry transmitters. It performs reliably under missile-launch conditions. For high-altitude operation, however, the transmitter package should be pressurized.

The X4540 is offered for L-band telemetry. Similar amplifiers for other frequency ranges between 500 and 2500 Mc are available on special order.

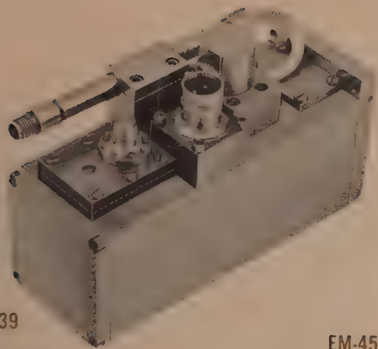
The X4541 is the appropriate power supply for these amplifiers. It operates from a 28-Vdc source. Special ac supplies can be furnished.

The EM-4523 amplifier produces 20–25 W for S-band telemetry transmitters with a drive of only 1–2 W. Its small size and light weight are major advantages in aerospace and transportable transmitters. Its high efficiency results in less battery drain, a smaller power supply, and less difficulty in disposing of waste heat. When used at high altitudes, the transmitter module should be pressurized.

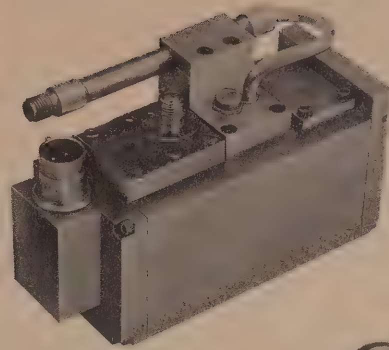
A similar amplifier, X4576, operates over the 2300–2600 Mc range.

The EM-4590 power supply (dc-dc converter) is recommended for use with this amplifier. Ac supplies are available on special order.

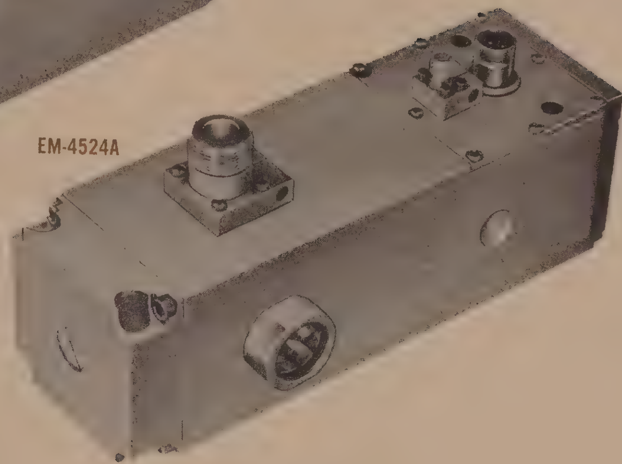
When used with the EM-4523, the EM-4582 low-pass filter provides 45-db 2nd-harmonic suppression and 60-db 3rd-and 4th-harmonic suppression.



EM-4539

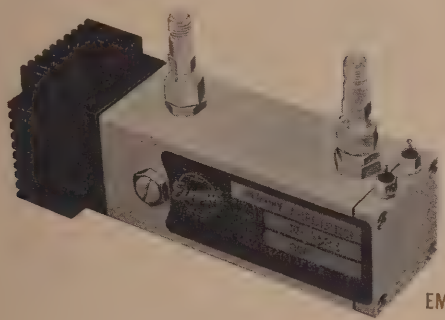


EM-4596



EM-4524A

from small packages



EM-4523

uhf amplifier characteristics

AMPLIFIER DESIGNATION		EM-4539	X4540	X4592	EM-4596	EM-4523	EM-4524A	X4576
ELECTRICAL								
Tuning Range, manual	Mc	1420–1600	1435–1540	1700–1850	2200–2300	2200–2300	2200–2300	2300–2600 Ⓐ
Power Output, CW Ⓑ	W	20	100	20	20	20	100	20 Ⓒ
Gain, minimum	db	10	10	10	10	10	10	10 Ⓒ
Bandwidth, 3-db	Mc	14	5	10	14	5	7	5
Load VSWR, constant phase Ⓓ		1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
Modulation		CW/FM	CW/FM	CW/FM	CW/FM	CW/FM	CW/FM	CW/FM
Triode Type, Eimac		128675	X843G	128675	128675	126066	X843G	128675
Anode Voltage	Vdc	600	1000	600	600	800	1000	800
Anode Current	mAdc	125	300	125	125	125	350	125
Filament Voltage	V	6.0	6.0	5.5	6.0	6.0	6.0	6.0
Filament Current	A	1.0	2.5	1.2	1.0	1.0	2.7	1.0
MECHANICAL								
Length Ⓔ	in	4.0	7.5	4.0	3.75	4.38	6.25	4.38
Width Ⓔ	in	2.5	2.0	2.5	2.5	1.25	2.0	1.25
Depth Ⓔ	in	1.5	2.0	1.5	1.5	1.25	2.0	1.25
Input Connector		OSM	OSM	OSM	OSM	OSM	OSM	OSM
Output Connector		OSM	N	OSM	OSM	OSM	N	OSM
Temperature Range	°C	−54 to +95	−40 to +100	−54 to +95	−54 to +95	−40 to +85	−40 to +100	−40 to +85
Weight	lb	1.1	6.1	1.1	0.95	1.2	5.7	1.2
Altitude, maximum	ft	No limit	10,000	No limit	No limit	20,000	10,000	20,000

Ⓐ Factory-adjusted for a tuning range of either 2300-2450 Mc or 2450-2600 Mc.
Ⓑ Under the most severe combination of specified environmental conditions. Output and efficiency are higher under optimum conditions.
Ⓒ At 2300 Mc; at 2600 Mc, output is 15 W and gain is 8 db.
Ⓓ Maximum for full rated output. Amplifier will withstand a load mismatch which produces a 3:1 VSWR without damage.
Ⓔ Dimensions of EM-4596, EM-4539 and X4592 include all protrusions; dimensions of other amplifiers exclude protrusions.

UHF and MICROWAVE CAVITY OSCILLATORS

Eimac CW cavity oscillators are designed for use in aerospace transmitters and other applications where size, weight, frequency stability and ruggedness are important. Both electronically-tuned and manually-tuned models are available. All models include ceramic-metal planar triodes and are cooled by conduction.

The EM-4543 is an ultra-stable, high-reliability, low-noise oscillator for use in radiosonde/rocketsonde and other 1–3 W FM/CW transmitters. All specification parameters are met over the temperature range of −40°C to +75°C. It operates satisfactorily under heavy shock and vibration conditions.

A factory-tuned version, EM-4578, can be supplied for any 20-Mc segment of the 1000–2000 Mc band.

The EM-4564 is similar to the EM-4543 but has a conductor inlet port in the plate cavity for modulation input.

The EM-4577 is electronically tunable by a varactor diode in the plate cavity. An electronic tuning range of ±7.5 Mc can be achieved anywhere in the 1650–1850 Mc band by varying the modulation input voltage to produce a shift in carrier frequency. Deviation sensitivity of this oscillator is nominally 1 Mc/V. Its linearity is ±1% for ±1-Mc deviation and ±15% for±7.5-Mc deviation.

The EM-4589 is the appropriate power supply (dc-dc converter) for these oscillators.

The EM-4522-5 oscillator is designed for 2-W S-band telemetry transmitters. The EM-4538-5 produces 3 W in L band. Both models have an electronic tuning range of ±6 Mc with ±5% linearity. With a linearity of ±2.5% or 1%, the tuning range is ±3 Mc or ±500 kc, respectively. Modulation frequency response is flat within 0.5 db for 0–2 Mc.

These oscillators meet all specifications over a heat-sink temperature range of −54°C to +85°C (other ranges on special order). Frequency stability is better than ±10 ppm/°C. They perform reliably under the environmental conditions of missile launch. Frequency adjustments within the specified band are simple to make.

Complete r-f packages which include a terminated ferrite circulator and a low-pass filter can be supplied.

A dc-dc converter for use with these oscillators is available on special order.

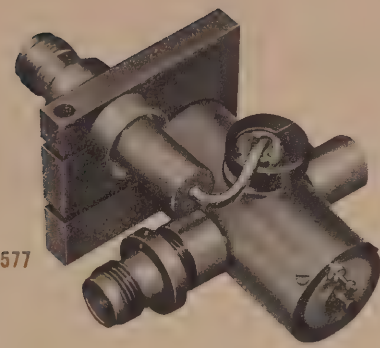
The EM-4585 is an ideal exciter for C-band transmitters. Its manual tuning range is 3900–5100 Mc. Frequency stability is ±10 ppm/°C from −40°C to +85°C. This model can be electronically tuned ±15 Mc by varying the input voltage of the varactor diode in the plate cavity. Carrier deviation is adjustable from ±3 to ±300 kc with 0.2 to 1.0 volt peak-to-peak modulating input voltage. Modulation bandwidth is flat within 1 db from 0.50 to 150 kc, and linearity (deviation from BSL) is ±0.5% from ±6 to ±300 kc.

The EM-4586 is a complete r-f package including the EM-4585 plus a terminated circulator, low-pass filter, and ganged tuning controls. R-f output is 100–300 mW.

The EM-4574 is an unmodulated, manually-tunable version of the EM-4585 with an r-f output of 100–600 mW.

The EM-4589 dc-dc converter is available for this oscillator and requires an input voltage of 28 Vdc.

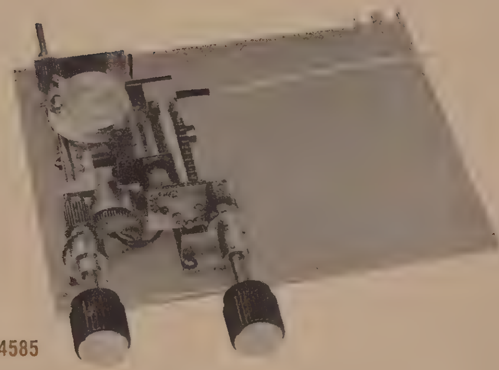
EM-4543



EM-4577

high stability and rugged construction

EM-4522-5

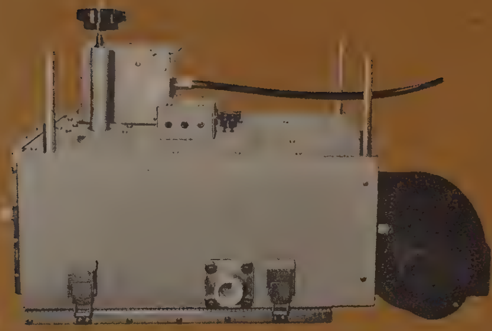


EM-4585

uhf and microwave oscillator characteristics

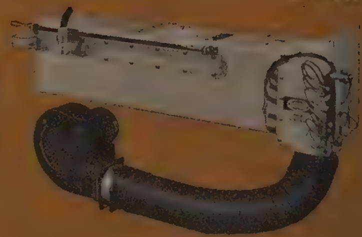
OSCILLATOR DESIGNATION		EM-4578	EM-4538-5	EM-4543	EM-4577	EM-4522-5	EM-4585
ELECTRICAL							
Tuning Range, manual	Mc	1000–2000 Ⓑ	1435–1540	1650–1850 Ⓐ	1650–1850 Ⓐ	2200–2300	3900–5100
Power Output, CW	W	2	3	2	2	2	0.1 Ⓒ
Frequency Stability	ppm/°C	±30	±10	±30	±30	±10	±10
Load VSWR, constant phase Ⓓ		1.3:1	1.2:1	1.3:1	1.3:1	1.2:1	1.5:1
Modulation		—	CW/FM	—	CW/FM	CW/FM	CW/FM
Triode Type, Eimac		128613	128613	128613	128613	128613	128676
Anode Voltage	Vdc	140	300	140	170	300	150
Anode Current	mAdc	50	70	50	50	70	35
Filament Voltage	V	6.0	6.0	6.0	6.0	6.0	6.0
Filament Current	A	0.4	0.4	0.4	0.4	0.4	0.3
Electronic Tuning Range	Mc	—	±6	—	±7.5	±6	±15
MECHANICAL							
Length	in	Ⓔ	2.95	2.25	2.25	2.95	4.5
Width	in	⅞ dia	1.0	0.85 dia	0.85 dia	1.0	1.0
Depth	in	—	1.75	—	—	1.75	1.0
Modulation Input Connector		—	OSSM	—	TNC	OSSM	OSSM
Output Connector		TNC	OSM	TNC	TNC	OSM	TNC
Temperature Range	°C	−40 to +75	−54 to +85	−40 to +75	−40 to +75	−54 to +85	−40 to +100
Weight	lb	Ⓔ	0.4	0.25	0.5	0.4	0.8
Altitude, maximum	ft	50,000	5,000	50,000	50,000	5,000	5,000

Ⓐ Factory adjusted for any 50-Mc segment of this band.
Ⓑ Factory adjusted for any 20-Mc segment of this band.
Ⓒ Up to 300 mW at maximum point in the band.
Ⓓ Maximum for full rated output. Oscillator will withstand a load mismatch which produces a 3:1 VSWR without damage.
Ⓔ Length and weight vary with frequency; maximum is 4 in. and 0.5 lb. at 1000 Mc, minimum is 2 in. and 0.2 lb. at 2000 Mc.


EM-4500

EM-4506

EM-4505



VHF CAVITY AMPLIFIERS

EM-4501

These cavity amplifiers are designed for use in AM and FM ground transmitters. The EM-4500 and EM-4501A are linear and power amplifiers, respectively, for the output stage of AM transmitters. The EM-4505 and EM-4506 amplifiers are for operation in intermediate or output stages of FM transmitters. Each cavity incorporates a modern Eimac ceramic-metal tetrode and employs forced air for cooling.

vhf cavity amplifier characteristics

AMPLIFIER DESIGNATION		EM-4500	EM-4501A	EM-4505	EM-4506
ELECTRICAL					
Tuning Range	Mc	145–150	145–150	122–150	122-150
Power Output, CW	W	300 Ⓐ	3000	30 Ⓑ	1000
Drive Power Required	W	3 Ⓐ	175	1	30
Bandwidth, 1.5-db	Mc	Ⓒ	Ⓒ	2	2
Modulation		AM Ⓓ	AM Ⓓ	FM	FM
Tetrode Type		4CX1000K	4CX3000A	4CX250R	4CX1000K
Anode Voltage	Vdc	3000	4500	400-800	3000
Anode Current	Adc	0.6	1.1	0.15 to 0.25	1.0
Screen Voltage	Vdc	325	300	80–175	250–350
Screen Current	mAdc	−100 to +125	125	−25 to +25	−100 to +125
Grid Voltage	Vdc	−10 to −100	−150	−35 to −60	−90 to −120
Grid Current	mAdc	−0.25 to +0.75	55	−25 to +25	−50 to +0.75
Filament Voltage	V	6.0	9.0	6.0	6.0
Filament Current	A	20	45	2.6	12
MECHANICAL					
Mounting		Ⓔ	Ⓔ	Ⓔ	Ⓔ
Height	in	16	18	13	24
Width	in	14	15¾	8½	15
Depth	in	12	15⅞	26	12½
Input Connector		N Female	N Female	N Female	N Female
Output Connector		LC Female	LC Female	N Female	LC Female
Cooling Required		50 cfm at 5 in. water	170 cfm at 1.6 in. water	Integral blower	Integral blower

Ⓐ Up to 1-kW output can be achieved with 15 W drive.
Ⓑ Up to 200 W with higher anode voltage.
Ⓒ 20 kc minimum at 3 db.
Ⓓ 0–100% amplitude modulation, 0–10,000 cps.
Ⓔ For 19-inch rack panel mounting.

BROAD TUNING RANGE CAVITIES high-power

These cavity amplifiers and oscillators combine high power output with unusually broad tuning range for use in laboratory test systems and special transmitters. Their wide tuning range reduces the amount of equipment needed for extensive frequency coverage. Ceramic-metal triodes are used in these signal sources. Power supplies and other accessories for these units are also available.

The EM-4547 amplifier combines an output of over 100 watts with a tuning range of almost three octaves. Hence, it is an outstanding general-purpose amplifier for any laboratory employing high-power rf in designing or testing microwave components. Its broad tuning range also makes it an ideal driver or final amplifier for special-purpose transmitters.

The EM-4555 is the recommended driver for this amplifier. Other r-f power sources may also be used for drive purposes.

The EM-4580 power supply is designed for use with this amplifier.

The EM-4512A oscillator has an extremely wide tuning range of 3½ octaves. Power output is 10–25 W in the 170–1000 Mc range and decreases to 2 W at 2000 Mc. This combination of wide tuning range and high power output makes the EM-4512A an unusually versatile signal source. Cooling is by conduction and convection — no blower is required.

The EM-4546 is an amplifier version of the EM-4512A. It is tunable from 300 to 900 Mc and delivers an output of over 25 W at mid-band with only 2 W drive. This amplifier may be used with signal sources having output from milliwatts to a few watts.

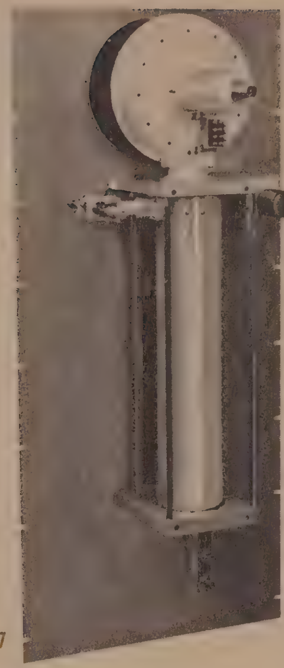
The EM-4555 oscillator is designed particularly for use with the EM-4547 amplifier, but it is also suitable for VHF and UHF test sets. Power output is more than 40 W from 150 to 300 Mc, and at least 10 W up to 1000 Mc.

The EM-4580 power supply is recommended for use with these broad tuning range cavities.

EM-4555

r-f signal sources for laboratory use

EM-4546



EM-4547

broad tuning range cavity characteristics

CAVITY DESIGNATIONS		AMPLIFIERS		OSCILLATORS	
		EM-4546	EM-4547	EM-4512A	EM-4555
ELECTRICAL					
Tuning Range, manual	Mc	300–900	150–1000	170–2000	150–1050
Power Output, CW	W	25–10	100 Ⓐ	25–2	40–5
Drive Power, CW	W	1–2	10	—	—
Gain, minimum	db	10 Ⓑ	10	—	—
Load VSWR, any phase, maximum		2:1	1.5:1	2:1	2:1
Triode Type, Eimac		Y319	X843D	Y319	Y319
Anode Voltage	Vdc	1000	1000	1000	1000
Anode Current	mAdc	100	250	100	100
Filament Voltage	V	6.0	5.5	6.0	6.0
Filament Current	A	1.0	2.7	1.0	1.0
MECHANICAL					
Height	in	8¾	42	8¾	8¾
Width	in	19	19	19	19
Depth	in	4½	14	4½	4½
Input Connector, female		TNC	N	—	—
Output Connector, female		TNC	N	TNC	TNC
Temperature Range	°C	−10 to +50	−10 to +50	−10 to +50	−10 to +50
Weight	lb	10	50	10	10
Cooling		Conduction Ⓒ	Liquid Ⓓ	Conduction Ⓒ	Conduction Ⓒ
Altitude, maximum	ft	12,000	12,000	12,000	12,000

Ⓐ Power output is at least 75W in the 975–1000 Mc portion of the band.
Ⓑ With one-watt drive.
Ⓒ If ambient temperature exceeds 90°F, forced-air cooling should be supplied.
Ⓓ Self-contained; no auxiliary cooling required.

LOW-PASS R-F FILTERS

These miniature low-pass filters are for use with L- and S-band telemetry and television transmitters, C-band command/control exciters, and similar equipment. Operation is reliable under the shock and vibration conditions of missile launch. They are coaxial, multiple-section, reactive types and are silver plated to minimize insertion loss.

EM-4581

filter characteristics

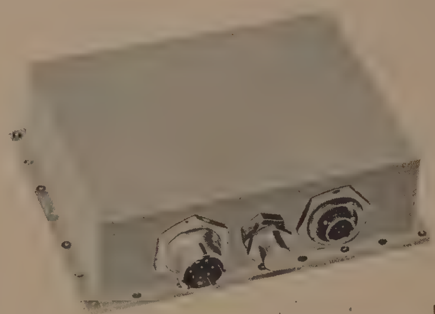
FILTER DESIGNATION		EM-4581	EM-4582	EM-4583
Pass Band	Mc	1435–1735	2200–2500	4400–5000
Power Rating, average	W	100	100	50
Insertion Loss, maximum	db	0.2	0.2	0.2
Attenuation, 2nd-harmonic, minimum	db	45	45	45
Attenuation, 3rd-and 4th-harmonic, minimum	db	60	60	60
VSWR, maximum		1.2:1	1.2:1	1.2:1
Impedance, nominal	Ω	50	50	50
Connectors, male Ⓐ		OSM	OSM	OSM

Ⓐ Strip-line connectors can be provided upon request.

POWER SUPPLIES

EM-4589, EM-4590, and X4541 are miniature, solid-state dc-dc converters which provide regulated plate and heater voltages for Eimac cavity amplifiers and oscillators. These compact, high-efficiency units are hermetically sealed for operation at any altitude. They operate from a 28-Vdc source. Cooling is achieved by conduction to a heat sink.

The EM-4580 is a regulated, solid-state, rack-mounted power supply which operates from a 115-Vac input and is used with laboratory cavity amplifiers and oscillators.



EM-4590

power supply characteristics

POWER SUPPLY DESIGNATION		EM-4590	X4541	EM-4589	EM-4580
Primary Source		28 Vdc	28 Vdc	28 Vdc	115 Vac
Plate Voltage	Vdc	600–700	1000	140–170	0–1000
Plate Current	mAdc	90–150	350	35–50	0–500
Heater Voltage	V	5.0–6.0	5.6–6.0	5.0–6.0	6.3
Heater Current	A	0.85–0.95	2.7	0.3–0.4	10
Cooling		Conduction	Conduction	Conduction	Forced Air
Height	in	1.7	3.0	1.0	10.5
Width	in	4.2	5.0	2.0	19
Depth	in	5.5	8.0	3.0	15
Weight	lb	2.5	7.5	0.8	80

eimac

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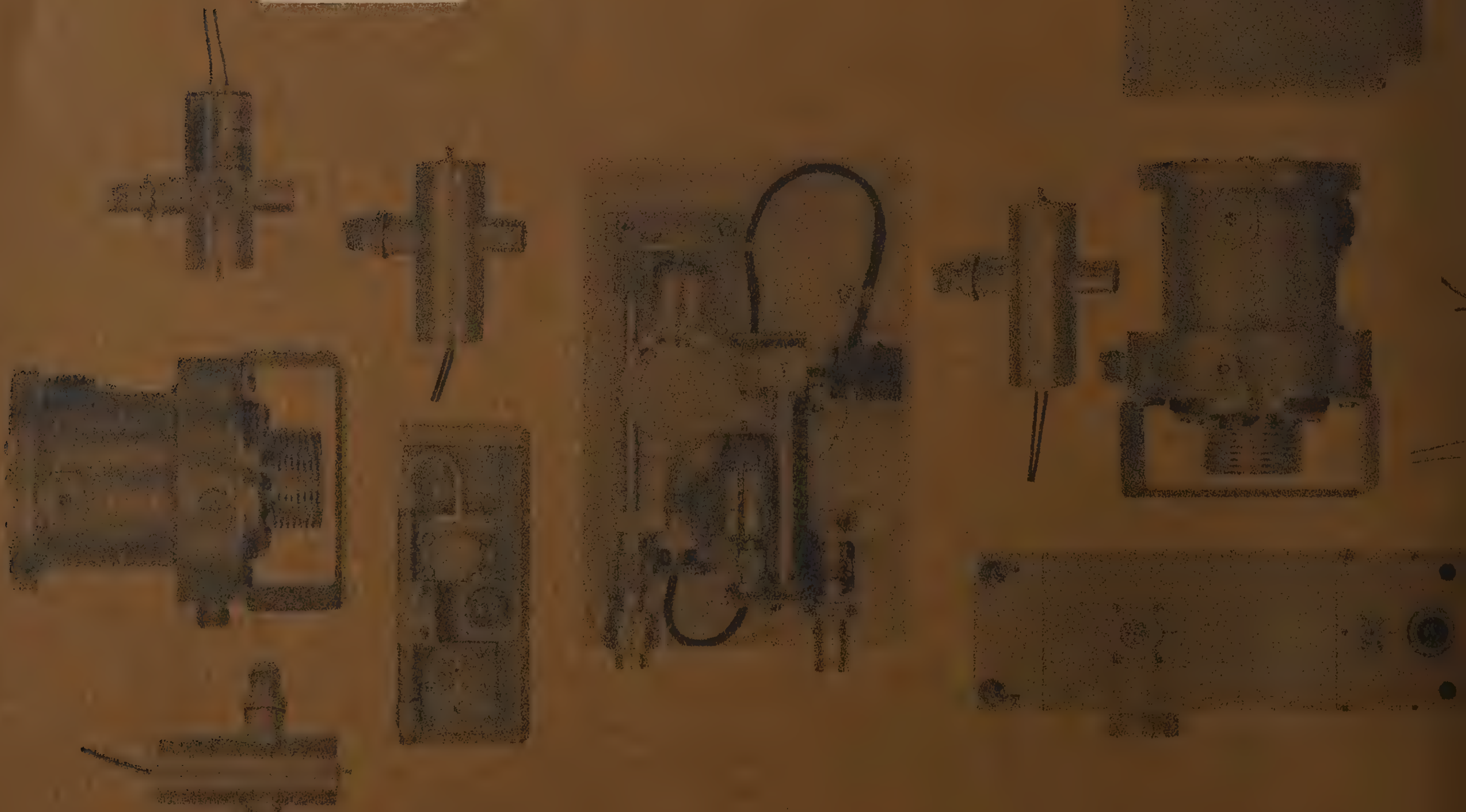

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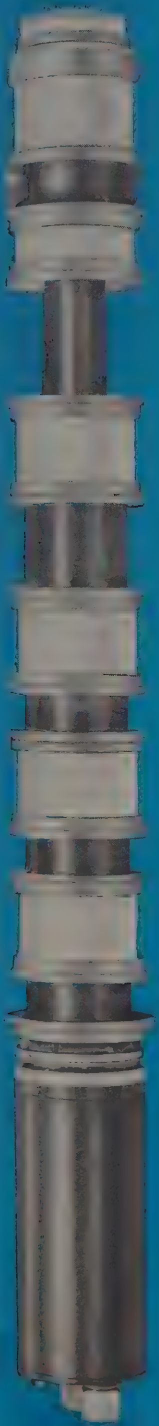
The Care and Feeding of

EIMAC EXTERNAL CAVITY

POWER KLYSTRONS

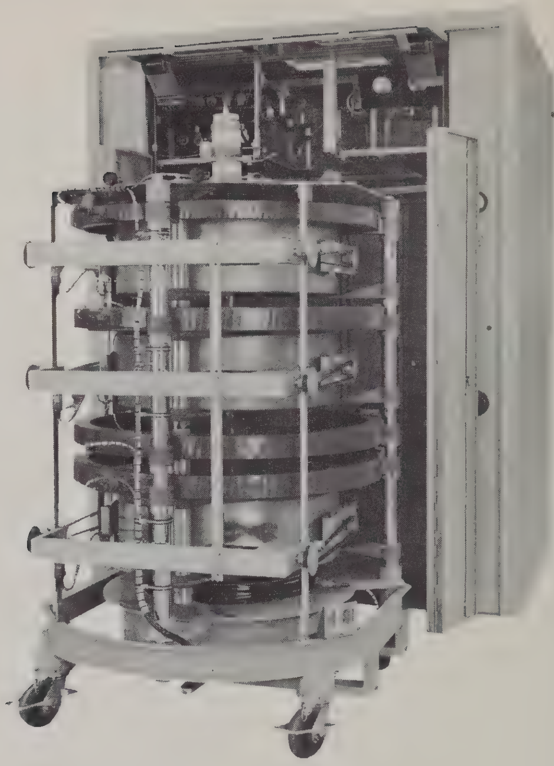


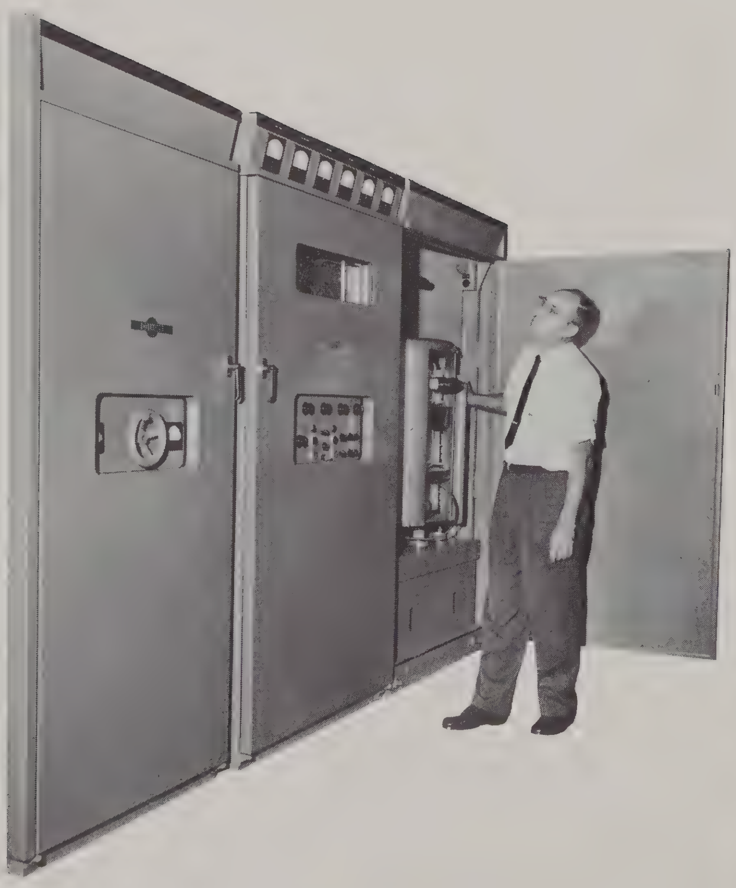
APPLICATION BULLETIN 10

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

20 kW power amplifier built by ITT Federal Laboratories. This amplifier, using the Eimac 3KM50,000PA klystron, operates from 225 to 400 Mc. The klystron carriage is shown removed from the amplifier cabinet.





Collins Radio Company's 240D-2 amplifier, which uses an Eimac 10 kW power klystron. These power amplifiers are part of the ground command control network used for control of Project Mercury manned space capsules. Additional 240D-2 amplifiers will be used to control Project Gemini two-man space flights.

REL 10 kW power amplifier using the Eimac 4KM50,000LR klystron. This amplifier covers the frequency range of 755 to 985 Mc.

Eimac®

TO SUBSCRIBERS OF THE EIMAC DATA SHEET SERVICE - VOLUMES I & II

Enclosed is a second binder (Volume II) for your Eimac Data Sheets. The Data Sheets on microwave tubes and components are to be filed in Volume II.

Also enclosed is a label marked Volume I which is to be used to identify your present binder. Please retain all Data Sheets on power grid tubes and their accessory products in Volume I.

Data Sheets which you will continue to receive may be conveniently filed in the appropriate binder. Tables of Contents for each volume will be issued periodically.

Thank you for your interest in continuing to receive this service.

Customer Services
EITEL-McCULLOUGH, INC.

Enclosures

CONTENTS

On the Cover—120-foot antennas used at one of the tropospheric scatter sites in the Aleutian Islands. This is one of the many tropospheric scatter installations using Eimac power amplifier klystrons. The transmitters at this site were manufactured by Radio Engineering Laboratories, and the installation was engineered and directed by Western Electric Company.

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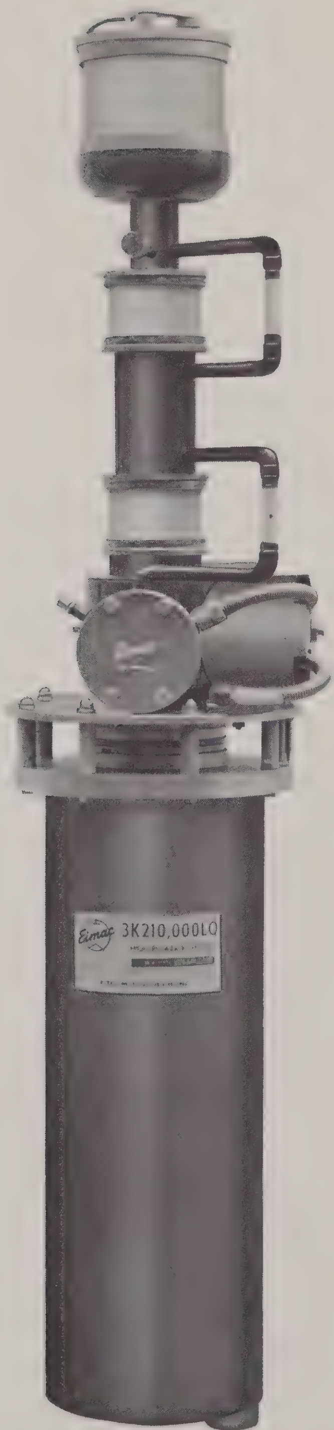
FOREWORD



Eimac 3K210,000LQ. This 75 kW klystron is used in many tropo-scatter systems spanning distances up to 440 miles. This klystron is unique in that its input and penultimate cavities are external but its output cavity is integral.

Eimac external cavity power klystrons, operating at frequencies from 225 to 985 megacycles, have earned a unique position in high power radio communications. They were used in the very first tropospheric scatter communications systems and proved to be so successful that they are now found in approximately 90% of all such systems in the free world. They are also used extensively in fixed radar installations and in UHF television.

Because external cavity klystrons are so generally used, almost everyone associated with high power radio communications will at some time be concerned with equipment using these tubes. For this reason Eitel-McCullough, Inc. believes that an application bulletin dealing exclusively with external cavity power klystrons will serve a useful purpose.

Eitel-McCullough, Inc. also manufactures a complete line of integral cavity power klystrons operating throughout the UHF and microwave spectrum. Information on these Eimac integral cavity klystrons will be found in other publications.

The information in this bulletin is arranged in six sections:

1. Introduction to the Klystron.
2. Mechanical Considerations.
3. Electrical Considerations.
4. Operating and Tuning.
5. Application of the Power Klystron.
6. Miscellaneous.

This application bulletin is intended to be a practical handbook for persons designing and operating equipment using external cavity power klystrons. For a more theoretical approach the reader should consult one of the many excellent textbooks available on the subject.

The information in this bulletin is based on data believed to be accurate, but no responsibility is accepted for the successful application of the systems or principles discussed. Likewise, no responsibility is accepted for patent infringement, if any, resulting from the application of this information.

The Care and Feeding of EIMAC External Cavity POWER KLYSTRONS

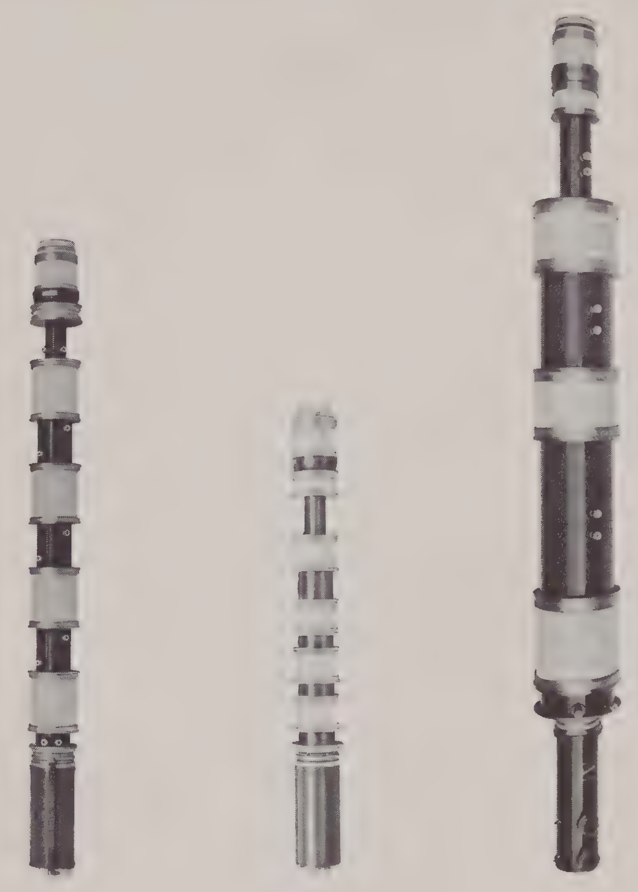


Figure 1 Figure 2 Figure 3

Section 1.0

INTRODUCTION TO THE KLYSTRON

The klystron is not as mysterious as it may seem to persons accustomed to using conventional tubes, even though it has no grid and no plate, and no lumped tuned circuits are connected to it by means of wires leading out of the tube. Actually the klystron is a simple device which exists for the same reason that conventional negative-grid tubes exist—it controls the behavior of electron streams flowing in a vacuum. The great difference between the klystron and the conventional tube lies not in *what* it does, but in *how* it does it.

Conventional triode or multigrid tubes, in which the electron flow is controlled by potential fields surrounding the grids, have upper usable frequency limits beyond which the electrons can not respond efficiently to the alternating control voltages applied to the grids. This occurs when the time required by the electrons for the transit of their paths becomes a substantial part of the period of one cycle at the operating frequency.

As a result of transit time effects, efforts to obtain satisfactory operation of conventional tubes at the higher frequencies have resulted in the development of extremely small tubes in which the lengths of the electron paths are reduced to the practical minimum. Such tubes are extensively used in low-power applications, but they are simply too small to control great amounts of power.

On the other hand, klystrons must be made relatively large in order to take advantage of transit time effects, which are essential to their operation. As a result, a klystron for operation near 500 megacycles, such as the 4KM50,000LA3 (Fig. 1), can be nearly 5½ feet long and produce more than ten kilowatts of useful CW output power. The 4KM50,000LR (Fig. 2), is a smaller klystron for operation at higher frequencies, and can deliver ten kilowatts output power at frequencies from 755-985 megacycles. The Eimac 3KM50,000PA (Fig. 3), for operation from

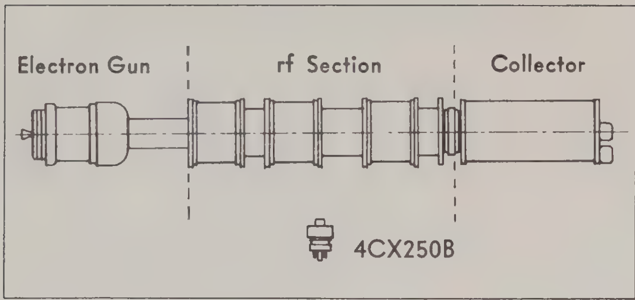


Figure 4—Typical Eimac Externally Tuned Klystron, Compared to a 250-Watt UHF Tetrode Tube.

225-400 megacycles, is nearly seven feet long and can develop over 20 kilowatts of CW power output.

A typical Eimac externally-tuned klystron is illustrated in Figure 4. It is apparent from the form of a klystron that it can be divided into three functional sections: the electron gun, the rf section, and the collector. In the following paragraphs, these parts of the klystron will be described in detail and their operation explained in simple terms.

1.1 The Electron Gun

The electron gun is the source of the electron beam upon which the operation of the klystron depends. The electron beam is simply a fast-moving stream of electrons expelled from the electron gun into the drift space of a klystron in somewhat the same manner that a jet of water is expelled in a solid stream from a nozzle.

A sectional schematic drawing of an electron gun of the kind used in Eimac klystrons is presented in Figure 5. The electrons destined to form the beam are emitted from a heated cathode and they flow away from the cathode along converging paths because of the specially shaped electric field set up by the electrodes.

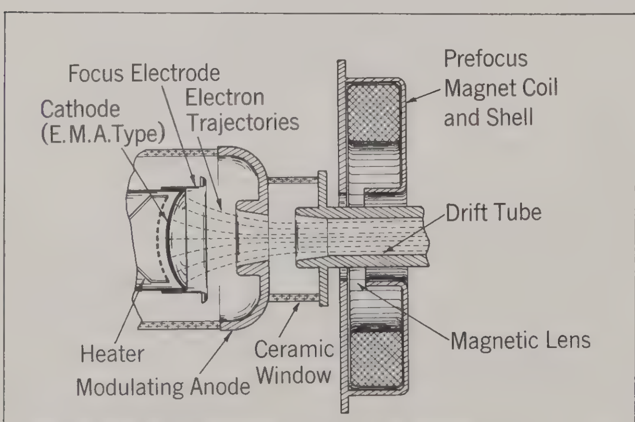


Figure 5—Simplified View of Electron Gun, Prefocus Magnet Coil and Entrance to Drift Tube.

The cathode is a concave section of an ellipsoid located inside one end of a cylindrical metal piece called the "focus electrode." Just beyond the opposite end of the focus electrode the modulating anode and first drift tube section are located. The focus electrode is maintained at cathode potential or at some negative potential with respect to the cathode. The modulating anode potential is positive with respect to the cathode. The positive charge applied to the modulating anode causes the electrons to flow away from the cathode toward the anode, and the negative or zero charge applied to the focus electrode tends to force them toward the axis. As a result of the two forces acting on the electrons, they form a converging beam, which focuses inside the first drift tube section. In klystrons which have no modulating anode, the end of the drift tube is formed into a cup which partially surrounds the cathode and serves as an anode.

Modern Eimac klystrons use oxide-coated cathodes at power levels up to and including 2 kilowatts. At higher power levels the Eimac Matrix Cathode Type A (EMA) is used. This cathode is made by pressing a mixture of powdered nickel and various earth carbonates under great pressure onto a nickel backing. Oxide-coated and EMA cathodes are easily heated by radiation from a filament or heater since they operate at relatively low temperatures.

Some of the older Eimac power klystrons use solid metal cathodes operating at relatively high temperatures. Radiation heating cannot be used in this case and the metallic cathodes must be heated by electron bombardment. This is accomplished by placing a filament behind the cathode and applying approximately 2000 volts dc between the filament and the cathode structure. Electrons emitted from the filament will travel at high velocities to the rear of the cathode, where they will release all their kinetic energy in the form of heat when they strike the cathode. By this means, the cathode can be heated to the operating temperature.

1.2 The rf Section

The rf section of a klystron is made up of the drift tube and the several resonant cavities which surround it at intervals along its length. The drift tube is an axial, interrupted tube with a length about twenty times its diameter. There may be from two to six interruptions, called "gaps," along the length of the drift tube.

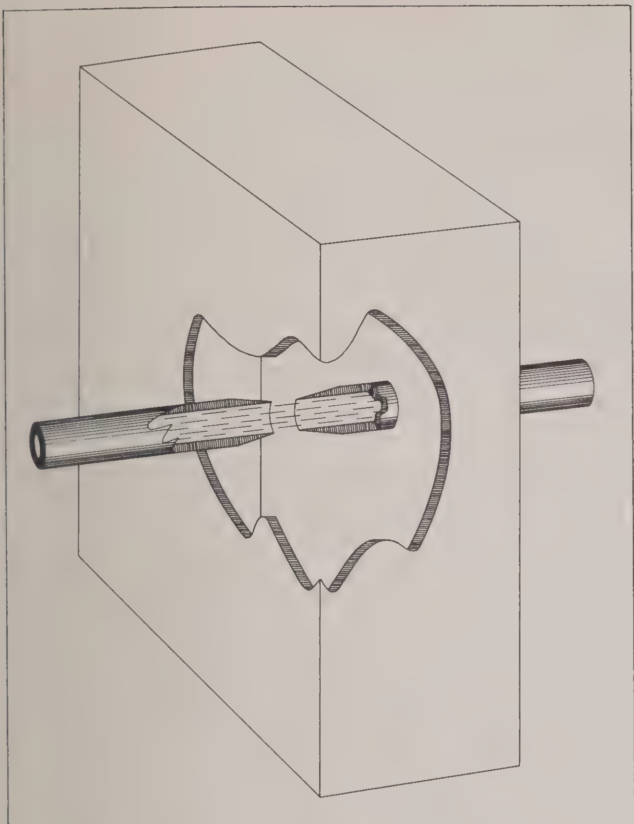


Figure 6—Simplified View of Resonant Cavity. Note Drift Tube Tips. Electron Trajectories Represented by Broken Lines.

A resonant cavity is constructed around each drift tube gap, as shown in Figure 6, and arranged so that the ends of the drift tube sections protrude into the cavity at opposing high-voltage points on the cavity wall. Thus, the drift tube tips become the capacitive loading elements in the cavity, and large rf voltages will be induced across them when the cavity is excited at resonance.

In Eimac external cavity klystrons, the drift tube gaps are surrounded by cylindrical ceramic envelope sections, and external demountable tuning cavities are assembled around the ceramic sections to form the complete cavities. The construction of the ceramic envelope and gap assembly, and the method of assembling a typical tuned cavity on the klystron body can be seen in Figure 7. In this type of resonator, only the drift tube gap is in the evacuated space, and the tuning mechanism remains entirely outside the vacuum. This permits a few klystron types of simple design to cover a relatively large frequency range.

1.3 The Collector

The electron beam transfers some of its energy to the rf circuits as it flows through the rf section of the klystron, and it carries the balance of its energy out of the rf section into an electrode called the "collector." The collector gathers the electrons and passes them out of the klystron into the external circuits leading to the positive terminal of the beam power supply.

The large energy content of the partially spent beam must be dissipated by the collector. When the electrons collide with the collector surface all their kinetic energy is transformed into thermal energy which heats the collector. The thermal energy is then transferred to the surroundings by cooling the collector with air or a liquid coolant such as water, or water in combination with antifreeze fluids like ethylene glycol.

1.4 The Axial Magnetic Field

The klystron requires a strong axial magnetic field to maintain and direct the electron beam throughout the length of the drift tube. The electron beam is a concentration of negative charges which tend to disperse because of the mutual repulsion existing between like charges. The axial magnetic field overcomes this tendency of the beam to disperse by exerting restoring forces on any electrons which try to move in directions not parallel to the axis. Thus, electrons attempting to move away from the axis of the beam are constrained to remain within the confines of the beam by the magnetic field.

The magnetic field is usually established by several individual electromagnet coils forming part of the magnetic assembly in which the klystron is mounted. The direct currents used to energize the electromagnet coils are sometimes made individually adjustable, to permit variation of the field strength along the length of the klystron if necessary. In many cases, however, the focus coils are so designed that they can be operated in series from a single power supply.

The proper use of the magnetic field is imperative to the long life and satisfactory performance of a klystron, and this matter will be discussed in detail in Section 4.

1.5 The Electron Beam

At the beginning of its passage through the drift tube the electron beam is a continuous stream of electrons moving at constant velocity. Although it is not confined to a wire, it is nevertheless a direct

Figure 7—Typical Eimac Klystron and One of Its External Cavities Before and After Assembly.

current of electricity, flowing through the free space enclosed by the drift tube. Ideally the beam would never touch the drift tube, but in practice there are always some electrons which stray far enough from the center of the beam to be caught by the drift tube walls.

Just as a direct current produces no sound as it flows through a headphone, so a direct current electron beam can produce no rf power as it flows through a klystron. It must be *modulated* in some manner before it can be useful and in the klystron this is accomplished at the drift tube gaps, which modulate the velocity of the electrons in the moving beam.

In Section 1.2 it was explained how a drift tube gap is formed by the ends of drift tube sections, which enter the cavity axially, from opposite ends. The cavity is designed so that the drift tube tips then become its highest voltage points, in order to build up strong radio frequency fields in the gap. This construction is clearly illustrated in Figure 6.

Velocity modulation occurs when the dc beam passes through the radio frequency alternating field established in the first drift tube gap by the rf driver. Following is how velocity modulation is accomplished, and how it transforms itself into density modulation as the beam passes down the drift tube.

Those electrons in the parts of the beam passing the first gap when it is "positively polarized" experience an increase of velocity because they will flow from a region of negative charge toward a region of positive charge. The negative region repels the electrons and the positive region attracts them, with the result that the velocity and the energy content of that part of the beam are increased. The energy gained by the faster parts of the beam is provided by the driving power furnished to the input cavity.

Conversely, the electrons in that part of the beam passing through the first drift tube gap during the half cycles of "negative polarity" will be forced to travel from a positive to a negative region. As a result they will lose velocity and surrender some of their energy to the input cavity.

The beam leaving the first gap is continuous and of uniform density, but alternate parts along its length will contain electrons having higher or lower velocities than they had before entering the gap. The faster electrons begin to overtake the slower electrons as the beam travels freely down the axis of the drift tube, until at some point a few inches from the gap, the fastest electrons will be traveling in company with the slowest electrons for a brief period. At that point, optimum "bunching" has occurred, and the density of the beam will vary periodically at signal frequency, when seen from a fixed point. In other words, the beam will have become a density-modulated beam. If a gap is located at the point of optimum bunching or "density modulation" the beam can be made to surrender many times as much energy as was originally required for velocity modulation. In other words, the klystron will have acted as a radio frequency amplifier.

Energy is extracted from the bunched beam by the same mechanism used to velocity-modulate it in the first gap. As the beam travels through the output gap, the gap polarity will vary in such a way that the denser portions of the beam will be decelerated while the less dense parts of the beam will be accelerated. As a result, there are many more electrons being made to give up energy to the circuit than there are electrons which take energy, and the net effect is to transfer power from the electron beam into the external circuits of the klystron.

The preceding paragraphs have described the action of a two-cavity klystron, in which rf power is used to velocity-modulate an electron beam, so that it can be made to surrender energy to another cavity after traveling a short distance down the drift tube. Experience has shown that klystrons having more

than two cavities offer advantages in higher gain and higher efficiency; as a result, three-cavity and four-cavity klystrons are in common use and klystrons with as many as six cavities have been used for special applications.

There is little or no reverse flow of electrons in the drift tube. The fields in the drift tube which are not due to the presence of the beam are so small that great isolation between the output cavity and the input cavity can be obtained. As a result it is possible to obtain stable operation with power gains of up to 50 db, in the case of four-cavity klystrons.

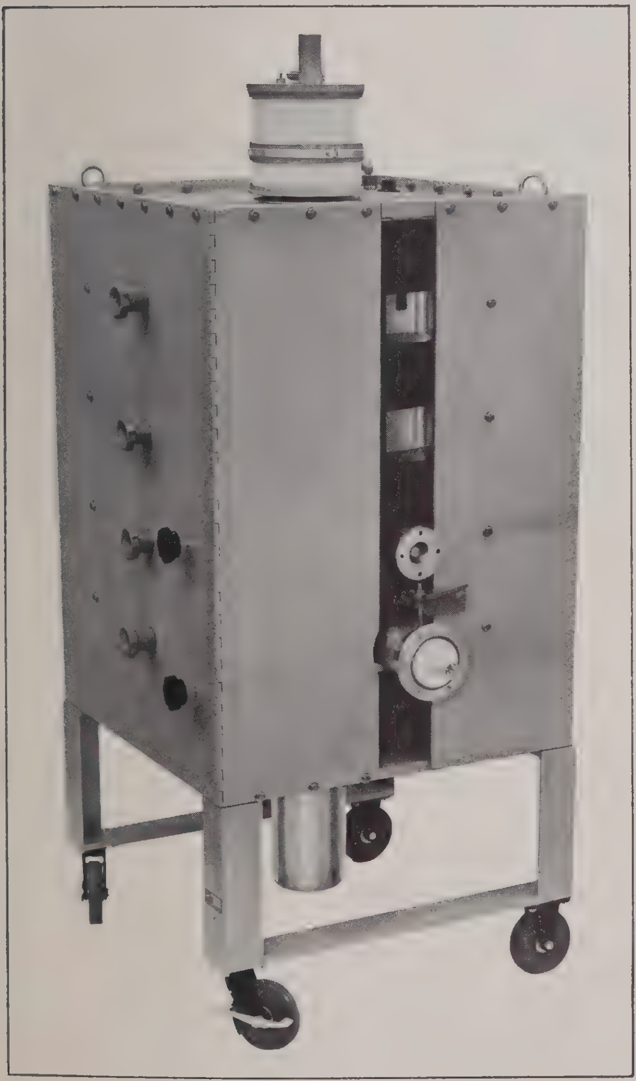


Figure 8—4KM100LA Klystron and H-163 Circuit Assembly. Designed for UHF Television, This Tube Develops 25 Kilowatts of Peak Synchronizing Power at Frequencies from 470 to 610 Megacycles.

1.6 Modulating Anode Klystrons

The klystron is a velocity-modulated device, and the velocity of the electron beam entering the drift tube must be maintained within certain limits if the klystron is to function well. Therefore, attempts to amplitude-modulate the klystron beam voltage with modulation factors larger than 0.3 have been unsatisfactory because the velocity depends entirely upon the beam voltage. Some means must be provided to modulate the beam intensity without varying the beam velocity if satisfactory amplitude modulation is to be obtained.

Certain Eimac klystrons, as shown in Figure 9, are designated by the letters "KM" in their type numbers, and are equipped with "modulating anodes." The electrode configuration of these klystrons is identical to that of standard klystrons, except that the anode of the electron gun is insulated from the rest of the klystron. As a result, the total accelerating potential difference between the klystron body and the cathode can remain constant, while the anode of the electron gun can assume any voltage between zero and the body voltage, with the result that the intensity of the electron beam can be varied at will while the total acceleration and the velocity remain constant.

The modulating anode makes possible amplitude modulation of the klystron with low distortion and high modulation factors. It also provides an excellent means for pulse modulating the klystron with minimum modulating power. In CW applications the modulating anode may be connected to the beam supply through a resistor to provide protection against internal arcs.

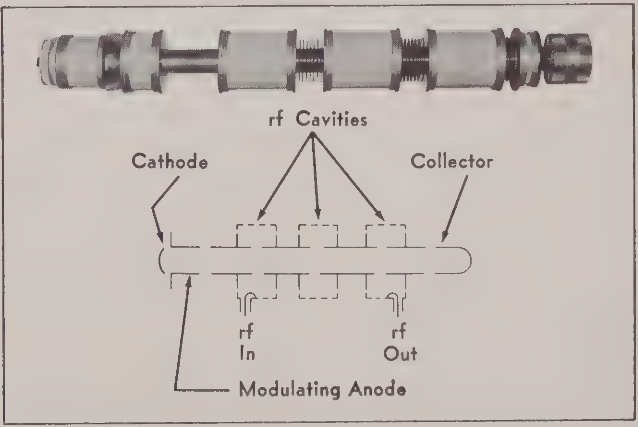


Figure 9—Eimac's Modulating Anode Klystrons Employ an Insulated Anode Placed Between the Cathode and Drift Tube Section.

1.7 Titanium Getter

Most Eimac external cavity power klystrons, rated at or above 10 kilowatts, employ a titanium getter which is designed to be energized simultaneously with the heater. The getter, which consists of a tungsten or molybdenum heater around which is wound a smaller titanium wire, is generally located near the upper end of the collector. One end of the getter is connected to the collector, the other to an insulated terminal.

Getter power supply requirements for Eimac external cavity klystrons range from 2 to 9 volts ac, at 20 to 33 amperes. Provision must be made to limit starting current to twice operating value. The purpose of the getter is to adsorb the small amounts of gas which may be released during operation from the normally hot or accidentally overheated surfaces of the klystron. The getter functions in two ways. The hot titanium adsorbs the common gases directly, and in addition a slow evaporation of titanium takes place which condenses on the walls of the collector to form a cooler layer of titanium to adsorb hydrogen and the inert molecules. In addition to its use during normal operation, the getter can be valuable in conditioning tubes which are unused for long periods of time. For example, site or warehouse spares can be maintained in good condition through periodic energizing of the getter.

Section 2.0

MECHANICAL CONSIDERATIONS

2.1 Shipping Klystrons

Eimac power amplifier klystrons are shipped in strong wooden boxes designed to protect the tube against damage during shipment. Special rubberized hair packs molded to completely fill the space between the tube and the shipping crate, or shock-mounted aluminum cradles, are used to protect and support the klystrons during shipment. These packs support the entire length of the klystron, and prevent accidental bending of the long body section.

Klystrons should be unpacked immediately upon receipt and inspected carefully. If possible they should be installed and operated in a klystron amplifier for a sufficient time to insure that they have arrived in usable condition.

2.2 Storing Klystrons

Klystrons may be stored vertically or horizontally until they are to be used. If vertical storage is preferred, they should be kept in racks, with the weight of the tubes supported by the mounting flanges. Horizontal storage requires the use of the shipping crates and their rubberized hair packing or cradle which provide support for the entire length of the tube body (Fig. 10).

Figure 10—Storage of Klystron in Shipping Crate.

2.3 Handling Klystrons

Eimac power amplifier klystrons of the externally tuned cavity type are among the sturdiest electron tubes being built today. However, they must be handled with the same care accorded to other types of tubes of the same weight and size if maximum tube life and satisfactory performance are to be obtained. The handling precautions which follow are simple and easily remembered.

The shape of the klystron makes it especially susceptible to bending near the center; therefore, the klystron should always be supported at two or more points when picked up in a horizontal position. (Fig. 11).

Water-cooled klystrons are equipped with heavy water-jacketed collectors in order to dissipate large amounts of power when necessary. The collectors of Eimac klystrons are insulated from the rf sections

Figure 11—Recommended Method of Hand Carrying Eimac Klystrons.

by ceramic envelope rings, and the ceramic-to-metal seals can be broken by rough handling, or lack of proper support. Therefore, when a klystron is picked up in a horizontal position the collector should be supported about one-third of its length from the inner end of the water jacket to balance the forces acting on the collector.

The larger Eimac klystrons are shipped in aluminum cradles which facilitate handling. These cradles are so designed that the klystron may be lifted to a vertical position while still strapped in its cradle, the collector end of the cradle may be removed, and the tube mounted in operating position prior to removal of the main cradle.

2.4 Acceleration Forces

Forces exerted on the tube structure as the result of sudden accelerations, such as occur when the klystron is dropped or set down roughly, can be destructively great. In the larger tubes, the structure is such that acceleration, such as could occur when the tube is picked up roughly by the center section, can bend the klystron body.

Some of the larger klystrons can be handled safely only when two persons move them, or when a hoisting device is used.

2.5 At the Bench

Occasionally it becomes necessary to place a klystron in a horizontal position for inspection and cleaning. Experience has shown that the safest and most convenient way is to use wooden V-blocks as supports. For short tubes, two blocks are usually sufficient, but long klystrons require three. When three blocks are used, they should offer uniform support to the tube, and one block should always support the full weight of the collector directly. (Fig. 12).

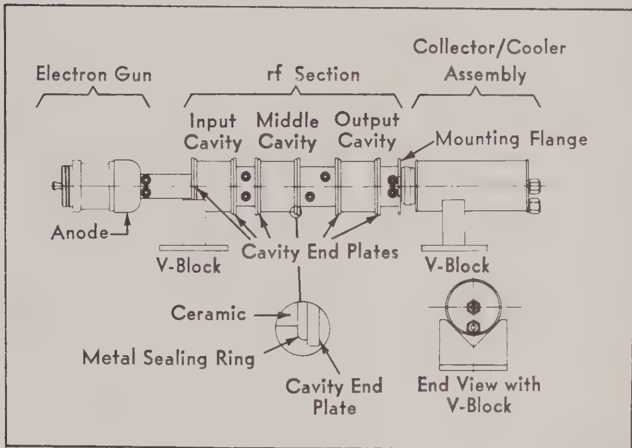


Figure 12—View of Klystron Mounted Correctly on V-Blocks.

V-blocks should be placed so that they touch the rims of the metal ends of the ceramic envelope sections. These metal surfaces are the contact surfaces which connect to the tuning cavities through spring finger contacts. Great care should be exercised to avoid marring or scratching these contacts, because the rf losses which can result are capable of destroying the contact fingers in the tuning cavities.

The massive metal end plates connected to the ceramic envelope sections of the klystron are not sufficiently flexible to be attached directly to the ceramic envelope cylinders. The vacuum-tight attachment between these parts is made by soft metal sealing rings, shown circled in Figure 12, which are intentionally made thin and flexible. In any handling or cleaning operation, care should be taken to protect these thin metal sealing rings against accidental damage.

2.6 Cleaning the Ceramic

Klystron ceramics are best cleaned with an abrasive household cleanser. A cleanser which does not contain bleaches or dyes is preferred. Scrubbing with a small stiff brush will help to remove baked-on deposits. The cleanser must be completely removed by rinsing with clean water before the klystron is restored to service or placed in storage.

2.7 Care of the External Tuning Cavities

The adjustable tuning cavities, which are assembled around the body of the klystron to form resonant circuits in conjunction with the drift tube gaps and their metallic end plates, must be maintained with care. The contact fingers should be protected against accidental deformation, because every individual finger must make effective contact with its opposing metal surface. The walls or metal parts against which the fingers bear must be kept clean and free of oxidation for the same reason. The tuning cavities may be cleaned by wiping them with a dust rag, but should not be left oily. A few drops of mineral lubricating oil or light application of grease should be applied to the adjusting screws if necessary, and all the excess lubricant wiped off.

2.8 Air and Liquid Coolant Supplies

All Eimac klystrons require air cooling, and some of them require water cooling of the collectors and drift tubes. Air circulated for cooling should be thoroughly filtered to avoid undue collection of dirt on the klystron. Accumulation of air-borne dirt on the ceramic envelope sections can cause local heating or voltage flash-over on the surface of the ceramic, and must be avoided.

The air filters should be inspected at suitable intervals to insure the free passage of air through them.

Water or other liquid used for cooling collectors and drift tubes of the larger klystrons must be free of minerals capable of encrusting the water passages and the metal surfaces being cooled. The use of a closed water-cooling system employing heat exchangers is the most satisfactory way to cool the large klystron. Aeration of coolant liquids containing water should be avoided in closed systems to keep oxidation effects to a minimum and derive the greatest benefit from closed-system operation.

In cold climates, where the coolant will be subjected to temperatures below 32°F, mixtures of water and ethylene glycol can be used in closed systems. The heat capacity of such mixtures is lower than the heat capacity of water, and the use of such mixtures will require some readjustment of the flow rates if equivalent cooling is to be obtained with them.

Aqueous solutions of ethylene glycol will freeze at temperatures which depend on the concentration of the ethylene glycol as follows: 25% ethylene glycol, 75% water, freezing point = 10° F (−12.2° C); 52.5% ethylene glycol, 47.5% water, freezing point = −40°F (−40°C).

Water mixed with ethylene glycol has greatly increased viscosities depending upon the temperature of the solution. This may change the indicated pressure drops in various parts of the cooling system as compared to the pressure drops observed when pure water is circulated.

2.9 Coolant Connections

The insulated envelope section interposed between the klystron body and the collector should be protected against unnecessary lateral forces tending to break the ceramic or its seals. The collector should be supported while the nuts on the water hose fittings are tightened, and the hoses should be sufficiently flexible to avoid exerting lateral forces against the end of the collector during operation. For the same reason, air ducts leading to air-cooled collectors should be flexible enough to avoid stresses resulting from poorly fitting duct work. The air connections to the air system socket and to the air-cooled cavities must also be made through flexible hose to avoid deforming the contact fingers in these devices.

Section 3.0

ELECTRICAL CONSIDERATIONS

3.1 High Voltage Protection

It is convenient to operate klystrons with their rf sections and collectors at or near ground potential. When this is done, the electron gun end of the tube, the focus electrode voltage supply, the cathode-heating supply, and the instruments associated with these must all be operated at high potentials with respect to ground.

Adequate interlocking devices must be provided to protect operating personnel against accidental contact with these high-voltage circuits, and any effort to defeat the purpose of these safety devices should not be tolerated.

Measuring instruments connected to the cathode end of the tube must be adequately insulated from ground and located behind glass or plastic windows to protect operating personnel.

The filament transformers and cathode-heating power supply transformers must be adequately insulated to withstand the total beam voltage (plus the bombarding voltage in certain klystron types).

3.2 Equipment Protection

Protective devices should be installed to avoid damage to the klystron as a result of malfunctioning of the associated equipment. A minimum complement of such devices would include:

(1) Air-flow and water-flow interlocks arranged to remove all electrical power supplied to the klystron in the event of failure in either or both of the cooling systems.

(2) Current overload relays to remove the beam power and the cathode heating power in the event that excessive current should flow in either of those circuits.

(3) Body current overload relay, arranged to remove the beam power upon the rise of body current beyond the maximum permissible value.

(4) Water-temperature or air-temperature interlock switches to remove the beam power in the event of collector overheating.

(5) Low power output interlock, or VSWR interlock to remove the beam power in case the output cavity becomes unloaded due to output line or antenna defects.

(6) Focus coil current failure interlocks to remove the beam power in the event of focus coil power supply failure.

3.3 Focus Coils

Klystron equipment must incorporate means for producing a controllable magnetic field, arranged so the flux is parallel to the axis of the klystron. The field is usually produced by two or more large electromagnet coils carrying direct current.

Each individual klystron may require slightly different magnetic field strengths to control and direct the electron beam, and these may change slightly each time the tuning is changed. Unless designed for series operation each individual coil should be furnished with an independent control for the current supplied to it, and each control must be capable of smooth, continuous adjustment. In addition, it is recommended that each coil be provided with an individual ammeter, permanently connected to its supply circuit. With series-connected coils, of course, only one ammeter is used.

All the electromagnet coils must establish their fields in the same direction. In equipment where all the terminals and the tops of the coils are marked, careful observance of polarity should assure correct field polarities. The polarity can be tested by means of a fluxmeter or by use of the galvanometer-and-loop method, in case doubt exists that the coils are correctly connected.

The direct current provided by the electromagnet power supplies should be filtered to 5% ripple, or less if minimum noise output is desirable. The design values should be stated so the operator can see that the filter circuits continue to function effectively.

The magnetic field will not remain parallel to the axis of the klystron if there are large steel or iron objects in or near the klystron amplifier frame. The magnetic frame of the amplifier should be located away from unsymmetrical cabinet work and in a place free of strong ac fields. Before operation is started, care should be taken that no tools or other magnetic materials are permitted to remain in the magnetic frame.

3.4 Instrumentation

The equipment associated with a power klystron should be provided with instruments to indicate the filament voltage, filament current, bombarder power (if used), beam power input, focus coil currents, body current and relative power output. The relative power indicator should be a sensitive instrument, arranged so that its coupling to the load can be varied to provide on-scale indications at any power level. The relative power indicator and the body current meter are the fundamental tuning tools available to the operator, and they must be located conveniently close to the tuning position. If this provision is not made by the equipment manufacturer, it should be done in the field before any attempt is made to tune the klystron.

It is convenient to operate a klystron with the rf section and the collector at or near ground potential. As a result, the instruments connected to the electron gun end of the klystron are necessarily at high potential with respect to ground. These instruments must be isolated from accidental contact with personnel, as outlined in Section 3.1.

It sometimes happens that instruments connected to circuits at high potentials with respect to ground may experience electrostatic forces exerted by fields set up between them and their surroundings. Errors resulting from this effect can be eliminated by the use of electrostatic shielding or guard circuits in the vicinity of the instruments.

Section 4.0

OPERATING AND TUNING

4.1 Test Data Cards

Every Eimac klystron is operated and tested individually in a standard Eimac Klystron Amplifier

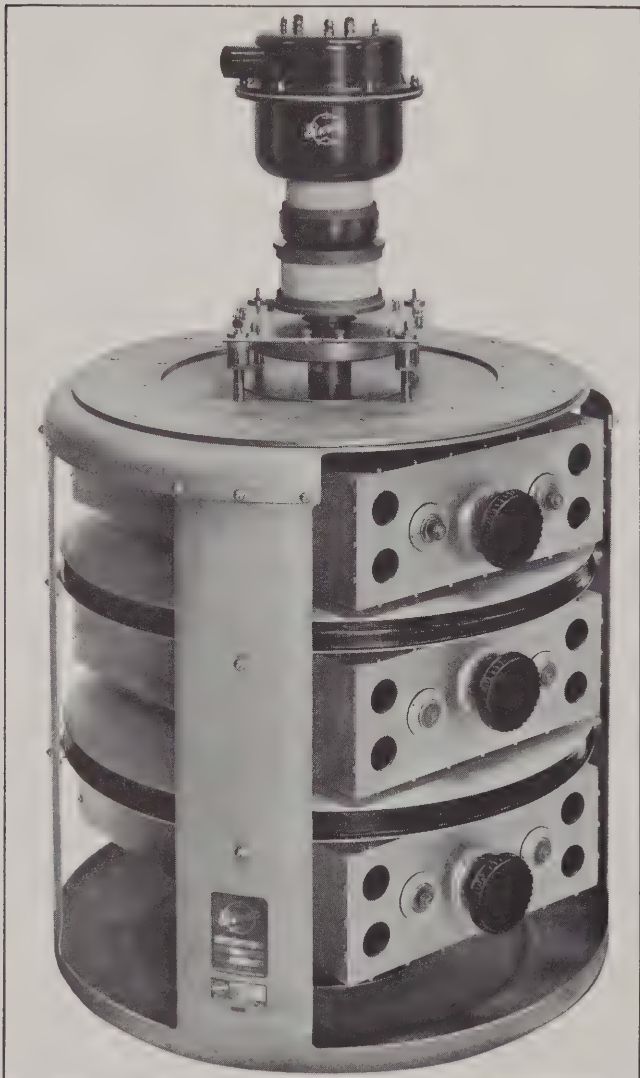


Figure 13—Typical Eimac UHF Klystron Amplifier Assembly.

Circuit Assembly (Fig. 13) before it is shipped to the customer. The complete tuning data and the conditions under which the klystron was operated are recorded in duplicate on test cards. One of these test cards is kept on permanent file at the factory, and the other is shipped in the same package with the klystron to which it belongs. This copy of the test card is one of the most important tools required by the transmitter operator, especially when the klystron is being operated for the first time in the field. A sample is shown in Figure 14.

TEST DATA

TYPE 4KM50,000LR POWER AMPLIFIER KLYSTRON EITEL-McCULLOUGH, INC. Eimac

SERIAL NO. A3-79-B E_f 7.5 I_f 39.6 GAS CHECK / DATE 2-1-63

F_o	E_b	I_b	I_{by}	E_{foc}	P_o	P_d	Eff	Im_1	Im_{2a}	Im_{2b}	Im_{2c}	Im_{2d}	Im_3		
985	12	1.06	10	-200	4.32	.025		1.0	3.0	3.0	3.0	-	3.0		
"	14	1.36	15	"	7.12	"		1.04	"	"	"	-	"		
"	17	1.89	30	"	12.1	"		1.10	"	"	"	-	"		
755	12	1.06	10	-200	5.18	.025		1.03	3.0	3.0	3.0	-	3.0		
"	14	1.36	15	"	7.78	"		1.05	"	"	"	-	"		
"	17	1.89	30	"	12.4	"		1.08	"	"	"	-	"		

E_f - AC FILAMENT VOLTAGE
I_f - AC FILAMENT CURRENT
F_o - FREQUENCY IN MEGACYCLES
E_b - BEAM VOLTAGE IN KILOVOLTS
I_b - BEAM CURRENT IN AMPERES
I_{by} - BODY CURRENT IN MILLIAMPERES
E_{foc} - FOCUS ELECTRODE VOLTAGE
P_o - OUTPUT POWER IN KILOWATTS
P_d - DRIVING POWER IN WATTS
Eff - EFFICIENCY IN PERCENT
Im_1 - PREFOCUS COIL CURRENT IN AMPERES
Im_{2a} - FIRST BODY COIL CURRENT IN AMPERES
Im_{2b} - SECOND BODY COIL CURRENT IN AMPERES
Im_{2c} - THIRD BODY COIL CURRENT IN AMPERES
Im_{2d} - FOURTH BODY COIL CURRENT IN AMPERES
Im_3 - COLLECTOR COIL CURRENT IN AMPERES

PLEASE USE REVERSE SIDE FOR SERVICE LIFE RECORDS

Figure 14—Test Data Card. (front)

SERVICE LIFE RECORD SERIAL NO

DATE RECEIVED CONDITION

SITE INITIAL GAS CHECK: ION ,ELECTRON

GAS CHECKS – RECOMMENDED EACH MONTH WHEN KLYSTRON IS NOT IN SERVICE

DATE															
ION CURRENT															
ELECTRON CURRENT															

DATE IN SERVICE	TRANS-MITTER	CARRIAGE	FILAMENT HOUR METER	BEAM HOUR METER	DATE OUT OF SERVICE	FILAMENT HOUR METER	BEAM HOUR METER	REASON FOR REMOVAL	TOTAL FILAMENT HOURS

Test Data Card. (back)

When a klystron is operated in several individual transmitters of the same type, its performance can be expected to vary slightly from one installation to another. Variations up to five percent are not usually cause for concern, but variations greater than ten percent often indicate maladjustment or trouble with the equipment.

4.2 Preliminary Focus Coil Adjustment

In new equipment, or in equipment in which the focus coils or their wiring may have been disturbed for any reason, the procedure outlined here and in Section 3.3 should be followed before the electron beam is started.

The prefocus coil should be centered physically around the neck of the drift tube and lightly held by the four locknuts at its corners. This preliminary adjustment is made visually, and it will be of aid in final centering later when the klystron is energized.

Before the beam is energized, the currents specified for operation at the lowest recorded beam voltage on the test data card must be established in the focus coils. These preliminary current values will change slightly during tuning, according to the requirements of the individual circuit, after the klystron is placed in dynamic operation.

4.3 Starting the Electron Gun

The cooling system must be placed in operation and its functioning checked before power is applied to the klystron. Large klystrons have electron guns which must dissipate considerable amounts of power, and they can be seriously damaged by operation without adequate cooling.

The magnetic field must be established in the klystron before any attempt is made to energize the beam. Although very low beam voltages will not usually damage a klystron operating without its magnetic field, damage can occur and it is not good practice to start the beam without first establishing the magnetic field. The electromagnet currents should be adjusted to the values corresponding to the lowest beam voltage shown on the test data card, and initial operation should not exceed that beam voltage.

Attention should be paid to the recommended focus electrode bias voltage. The correct value for normal operation of the klystron is recorded on the test card and should be used during all preliminary tuning operations. Small adjustments in the beam current obtained at any fixed beam voltage can be obtained by variation of the focus electrode voltage around the recommended value, which is not critical.

Two distinct methods of heating cathodes in Eimac klystrons are in general use: direct radiation heating, and electron bombardment heating. The starting instructions for electron guns using each of these methods are given in the following sections:

4.3.1 Starting the Electron Gun, Radiation-heated Cathode Type:

1. Start cooling system, check its operation.
2. Establish recommended currents in focus coils.
3. Increase heater voltage gradually to the rated value, holding the heater current to the specified value.
4. Apply the focus electrode voltage if this is obtained from a power supply. If the focus electrode voltage is obtained from a cathode series resistor, this should be set to approximately its operating resistance.
5. Permit the cathode to heat as specified.
6. Beam voltage may now be applied to the klystron in accordance with Section 4.4.

4.3.2 Starting the Electron Gun, Bombarded Cathode Type:

1. Start cooling system, check its operation.
2. Establish recommended currents in focus coils.
3. Increase filament voltage gradually to the rated value, keeping filament current to the specified value.
4. Apply bombarder voltage, increasing it gradually until rated bombarding power is obtained.
5. Apply focus electrode voltage specified for the type klystron in use if this is obtained from a power supply. If the focus electrode voltage is obtained from a voltage divider across the bombarder supply, it should be pre-set to approximately the correct value.
6. Beam voltage may now be applied to the klystron in accordance with Section 4.4.

4.4 Applying Beam Voltage

Initial adjustment and operation of the klystron must be done at the lowest voltage specified on the test card provided with each tube. Failure to observe this rule can result in the destruction of the klystron.

The beam voltage may be applied only after the recommended magnetic field has been established in the equipment, the prefocus coil centered visually, and the electron gun started.

4.5 Magnetic Field Coils

The magnetic field which guides the electron beam in an Eimac klystron is created by controlled amounts of direct current flowing in electromagnet coils surrounding the klystron (Fig. 15).

The number of coils required is not the same for all types of klystrons, but operators will find four or five coils in most transmitters. These are the prefocus coil, several body coils and the collector coil.

The purpose of the magnetic field is to control the diameter and direction of the electron beam as it flows through the klystron, so that as little beam current as possible will strike the drift tube walls and be wasted. It follows that the best adjustment of the focus coil currents is the setting for minimum

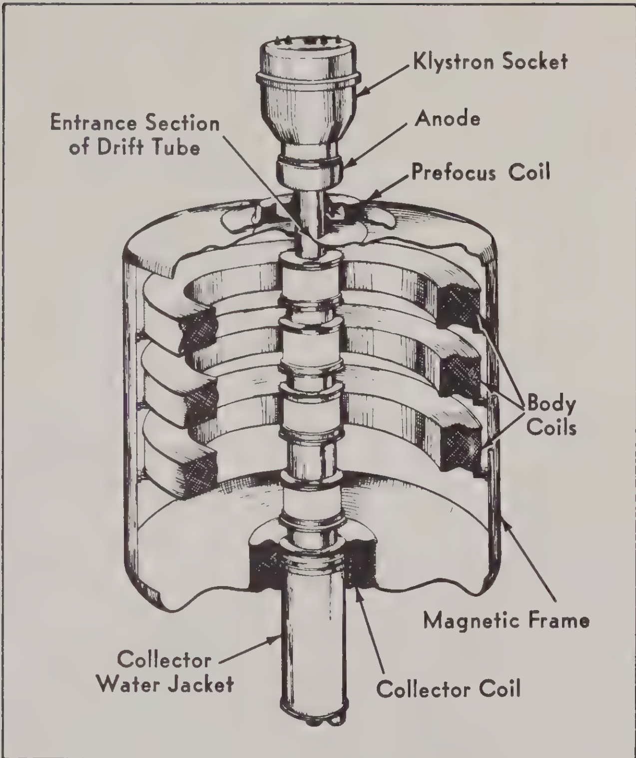


Figure 15—Simplified View of a Klystron and Its Magnetic Circuit with the Tuning Cavities Removed.

body current, consistent with good output. Sometimes slight changes in the coil current settings will produce large changes in power output without correspondingly great body current changes. In such cases, if the body current is not too near the permissible maximum, it is wise to adjust for a compromise body current setting which permits the larger power output to be obtained.

Each time the rf circuits are tuned, some changes will take place in the velocity and bunch density of the beam, which may increase the body current. As a result, each readjustment of the rf tuning will usually make it necessary to trim the focus coil currents slightly to obtain minimum body current again. This behavior is normal, and the adjustment is not critical despite its importance.

Focus coil resistances undergo considerable variation as the coils heat up after being turned on. The effects of this resistance variation on the coil current must be corrected by some means, and in transmitters where the currents are controlled manually, the operator should make frequent checks on the coil currents and over-all klystron operation during the warm-up period.

4.5.1 Prefocus Coil (Not Required for Some Klystrons)

The prefocus coil is much smaller than the body coils used with the klystron, and it is enclosed in a special magnetic shell containing an annular air gap. The flux outside of the air gap forms a magnetic lens located on the axis of the klystron at the approximate point where the convergent paths of the electrons would focus. This magnetic lens overcomes the tendency of the electron paths in the beam to diverge and strike the drift tube wall before the beam enters the main magnetic field, and it directs the beam down the center line of the drift tube. To accomplish these two ends, the prefocus coil requires two separate adjustments: the current must be correctly set, and the correct position of the coil around the axis of the drift tube must be found.

The initial current settings should be those shown on the test data card, for the lowest operating beam voltage specified. After the magnetic field has been established and the beam energized, the locknuts on the prefocus coil mounting pillars can be loosened and the coil carefully positioned to obtain the lowest possible body current (Fig. 16). When the optimum

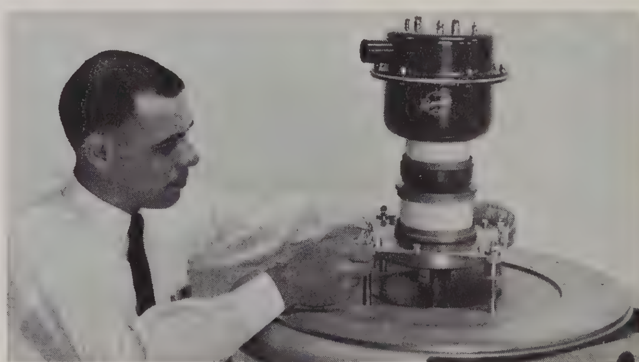


Figure 16—Adjustment of Prefocus Coil.

position has been located, the coil may be locked in place again.

The prefocus coil mount should *never* be unlocked at beam voltages higher than the low beam voltage used during the position adjustment just described. To move the prefocus coil at higher beam voltages is to invite destruction of the klystron and, although it can be done in some instances by experienced personnel, moving the prefocus coil during high-voltage operation is NOT recommended.

Some of the newer Eimac external cavity klystrons do not require prefocus coils. This is because they use confined flow electron gun designs which make prefocus coils unnecessary. In the confined flow principle the main magnetic field is permitted to extend through the cathode and is so shaped that the electrons are confined by the field from the instant they leave the cathode. This minimizes focusing adjustments and provides a more stable beam.

4.5.2 Body Coils

Many body coils are supported in the klystron amplifier frame by small mounting pillars, which are secured to the side bars by single machine bolts running in tapped eccentric holes in the support pillar base. By this means, the support pillars can be rotated to provide four-point suspension of the coil, and the body coils can be levelled within small limits. The coils are positioned on the axis by small shoulders turned on the bodies of the mounting pillars.

Once the coils have been correctly set on the mounting pillars, it only remains to adjust the currents during the process of tuning the klystron amplifier. The original current values required are given by the test data card for each beam voltage. The test values should be used as starting points, and the final currents should not deviate greatly from them. In most cases, deviation from the test values of more than ten percent will result only when an error has been made in setting up the adjustments, or in assembly of the equipment.

4.5.3 Collector Coil

The collector coil is located around the soft steel sleeve in the bottom of the magnetic frame which supports the mounting flange of the klystron. The mounting flange is also made of magnetic material, and it serves to establish the magnetic field needed near the collector end of the drift tube whenever the collector coil is energized. The collector coil current adjustments are made in the same manner as the body coil current adjustments, and with the object of reducing the body current as much as is consistent with good power output.

4.5.4 Results of Improper Adjustment of Focus Coils

If the focus coils are improperly adjusted so that the electron beam is not centered in the drift tubes or if the beam is too large in diameter, it will graze the drift tube tips and evaporate copper which will raise the gas pressure in the tube and possibly poison the cathode. In extreme cases the drift tube tips may be partially melted by the beam. On the other hand, if the beam is over-focused by using an excessively strong magnetic field, the beam size is too small as it leaves the field and therefore it will not spread properly before it strikes the collector, with resulting damage. It is quite possible to burn a hole in the collector if the beam is overfocused.

Correct focusing of the electron beam is accomplished by keeping the body current well below the maximum limit at all times using focus coil currents that do not deviate more than 10% from those shown on the Eimac test data card. Adjustment of the focus coil currents should be made carefully so that the body current overload relay is seldom, if ever, called upon to operate. If the beam is thrown considerably out of focus it is quite possible for the tube to be damaged before the body current overload relay can operate.

4.6 Beam Transmission and Beam Loss

Some of the electrons in the klystron beam will inevitably strike the drift tube walls, instead of passing on through the klystron to the collector. Captured by the wall of the drift tube and returned to the external electrical circuits (through the body current milliammeter), these electrons are totally wasted as far as the production of rf power is concerned. The electrons lost in this manner are called the "body current," and the rest of the electron beam, which reaches the collector, is called the "collector current." The sum of the collector current and the body current is equal to the total beam current emitted from the cathode.

The collector current, expressed as a percentage of the total cathode current, is called "beam transmission."

The body current, expressed as a percentage of the total cathode current, is called "beam loss."

4.7 Tuning the Klystron

It has been noted that klystrons may have any number of cavities, but those most common in the field have either three or four. The nomenclature for klystron cavities has arisen from the functions they perform, and it is natural that the first cavity be called the "input cavity," no matter how many cavities may follow it.

Similarly, the last cavity transfers power from the electron beam to the output transmission line, and it is logically referred to as the "output cavity."

The cavity preceding the output cavity is tuned by the same rules regardless of whether the klystron has three, four, or more cavities. Therefore, it is convenient to refer to this next-to-the-last cavity by some descriptive word independent of the number of cavities which precede it, so it will be referred to as the "penultimate cavity."

The remaining cavities, not given descriptive names according to the scheme outlined above, are referred to by their position on the drift tube as the "second cavity," "third cavity," and so on. Most Eimac external cavity klystrons use either three or four cavities and the following tuning instructions will therefore be chiefly concerned with these tubes.

Before driving power is applied to the input cavity

of a klystron, the tuning cavities should all be adjusted to the highest possible frequency. This is done by moving the tuning doors as far as possible toward the centers of the cavities. The output load coupler should also be adjusted for maximum coupling (loop vertical). After this is done, beam power and rf drive can be applied to the klystron and tuning may begin.

The tuning procedures which follow will apply particularly to narrow-band, maximum-gain amplifier operation. The procedures for broad-band klystron operation are ordinarily evolved for each individual application, and therefore cannot be treated as generally as can the narrow-band case. (See Section 5.3 for broad-band application information.)

The operator should not permit his familiarity with conventional electron tube behavior to confuse him when he tunes a klystron amplifier. In some respects a klystron behaves like a linear amplifier using conventional electron tubes, because the "plate current" does not change during tuning and the best indicator of correct tuning is the power output. Furthermore, when the driving power level is increased to a point above "saturation" the power output will start to fall with increasing driving power, which is similar in some respects to "overloading" a conventional amplifier circuit (Fig. 17).

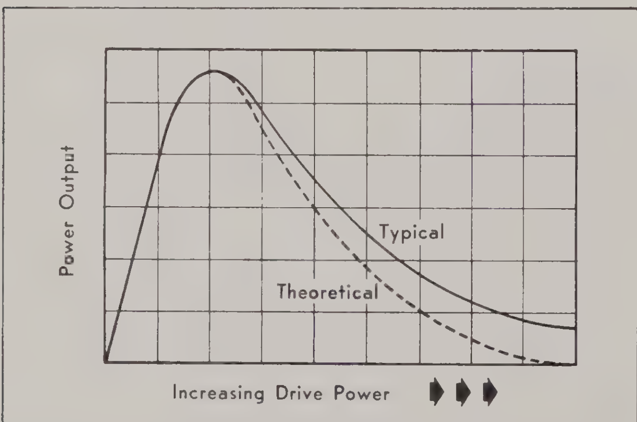


Figure 17—Overdriving a Klystron Reduces Output.

The klystron offers the operator the advantage that he can be guided in his actions by the variations in body current resulting from changes in the rf tuning adjustments. As each cavity is tuned, the body current may vary, and it is often necessary to trim the focus currents after each readjustment of the rf tuning, especially when the klystron is operating near its highest efficiency at any given power level.

Many Eimac klystrons carry dual body current ratings. One of these is intended for use during long periods of continuous operation and is usually half the absolute maximum rating. The absolute maximum rated body current is established for observance during tuning operations, to free the operator from the necessity of stopping frequently to trim the focus currents and to avoid tripping overload current relays frequently during tuning.

4.7.1 Input Cavity Tuning

The input cavity is tuned to resonance at the driving frequency. A beam voltage equal to 50% of that required for full rated power is applied to the klystron during this adjustment. Resonance is usually indicated by tuning for minimum VSWR at the input cavity. A directional coupler is ordinarily inserted in the driving line for this purpose. The two tuning doors of the cavity should always be equally spaced from the ceramic cylinder. The input cavity coupling loop should be adjusted to the position giving lowest reflected power as indicated by the directional coupler in the drive line. This is the condition of best match for the drive line. The input cavity must be resonated after each coupling adjustment. After the coupling is adjusted for best match, the driving power should be set at the value specified for the particular klystron. This power can be measured with a bolometer at the incident power terminals of the input directional coupler. After the input cavity is tuned, the second cavity (if applicable) and output cavity tuning doors should be adjusted to approximately the same positions as those of the input cavity. Since the cavities are similar, this will approximate resonance. The penultimate cavity tuning doors should next be set at positions midway between those of the input cavity and the maximum high frequency setting (tuning doors nearest to klystron).

4.7.2 Second Cavity Tuning
(Ignore for 3 cavity klystrons)

The second cavity is also tuned to resonance at the driving frequency (unless stagger tuning is employed for broad-band operation). This is accomplished by tuning for maximum output power. It will probably be necessary to adjust the output cavity to resonance at this time in order to obtain adequate output power for tuning purposes. The relative power output indicator must be sufficiently sensitive to detect the low power output during this tuning procedure.

4.7.3 Penultimate Cavity Tuning

After the input and second cavities are resonated, the beam voltage can be increased to the lowest value shown on the Eimac test data card. (Adjust

focus coil currents for minimum body current). The input and second cavities should then be rechecked for resonance because their tuning may change as the beam current changes. The penultimate cavity can then be slowly tuned toward a lower frequency as the output power is carefully observed. As the cavity is tuned, the output power will increase to a maximum and then start to decrease. Return the tuning to the point which gave maximum power output and then detune on the high frequency side until the output power drops 10%. This is the correct tuning point for the penultimate cavity. See Fig. 18.

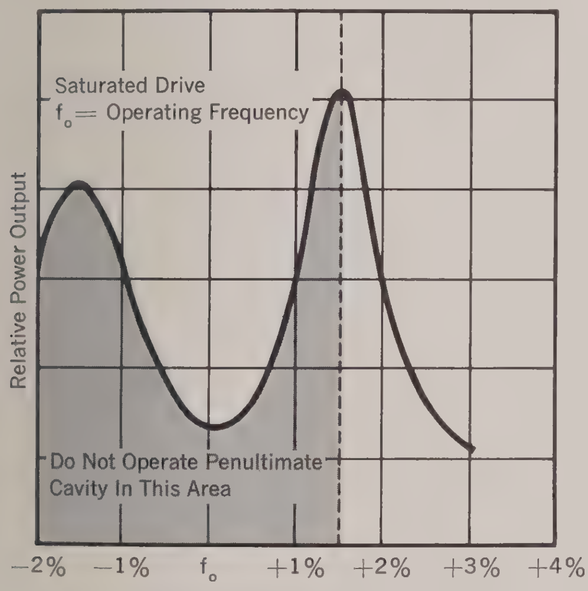


Figure 18—Penultimate Cavity Tuning

4.7.4 Output Cavity Tuning

After the penultimate cavity is tuned, the output cavity is retuned for maximum output power. Next the output coupling is adjusted. Starting in a vertical position the coupling loop is moved in 5° steps toward a horizontal position. The output cavity must be retuned at each step because its resonant frequency will change as the coupling is adjusted. As the output coupling is reduced the output power will increase. Eventually optimum coupling (maximum power) will be reached and if the coupling is further reduced the output power will start to decrease. *Do not reduce the coupling past the point of optimum coupling*. Instead, increase the coupling until the output power drops to 95% of its value at optimum coupling (see Fig. 19). The klystron is now correctly tuned at the lowest beam voltage shown on the Eimac test data card and the output power should be near the value shown on the test data card. If it is not, the tuning procedure should be repeated until the reason for the discrepancy is discovered.

At the lowest beam voltage shown on the Eimac test data card mistakes in tuning will not ordinarily injure the klystron and it is suggested that the operator take this opportunity to practice tuning the klystron and familiarize himself with its behavior before increasing power.

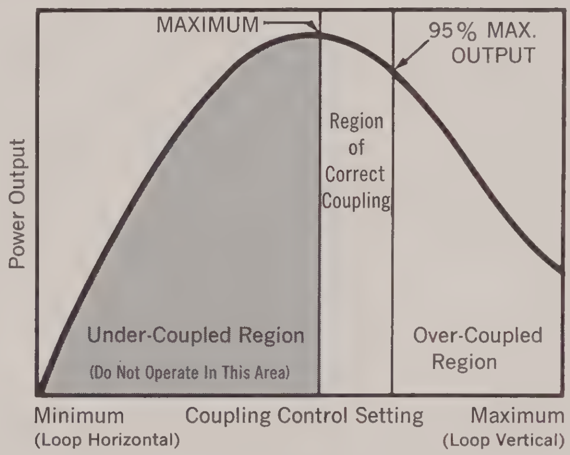


Figure 19—Adjustment of Output Coupling Control.

4.7.5 Load VSWR Check

After the klystron has been tuned at the lowest beam voltage shown on the Eimac test data card, the load VSWR should be determined by comparing the incident and reflected power measured at the directional coupler in the output transmission line. Most Eimac external cavity power klystrons will deliver rated output power with any load VSWR up to 1.5:1. This is equivalent to 4.2% reflected power with respect to forward power. If the reflected power exceeds this value the load must be adjusted to reduce the VSWR to 1.5:1 or less before the beam voltage is increased.

4.7.6 Trimming

When the tuning procedure has been completed and the operation appears reasonably satisfactory, each adjustment in turn should be trimmed to assure the operator that optimum performance has been obtained. When satisfactory operation at any given power level has been obtained, operation at the next higher power level may be started.

4.8 Increasing Power

Before increasing power the following precautions must always be taken.

1. Increase the frequency of the penultimate cavity until the output power decreases by 50%. (Move tuning doors toward the center of the cavity.)

2. Increase the output coupling to maximum. (Coupling loop vertical.)

The beam voltage may then be increased in steps to the desired value. Observe the body current during each voltage increase and adjust the focus coil currents as required to keep the body current at minimum. After the desired beam voltage is reached, the input cavity and second cavity (where applicable) are again checked for resonance. Next the penultimate cavity is tuned exactly as described in Section 4.7.3 and finally the output coupling and output cavity tuning are adjusted exactly as described in Section 4.7.4. If the output power obtained in this way is greater than required, the output coupling should be increased until the desired output is obtained.

Section 5.0

APPLICATION OF THE POWER KLYSTRON

Figure 20 shows the filament and beam supplies, protective circuitry and instrumentation for a klystron amplifier. Focus coils and their power supplies have been omitted for simplicity. Commonly used abbreviations for klystron electrical characteristics are shown in Figure 21. Heater voltage and current (E_f, I_f) are typically supplied from a transformer, insulated for high voltage, and a variable autotransformer. The heater transformer is often designed to be short circuit limited to twice the normal heater current rating. The heater voltmeter should be connected directly to the klystron socket to minimize measurement errors due to voltage drop in the connecting cable.

Resistor R_{surg} is the current limiting resistor for the beam supply. Its value should be chosen to limit short circuit current to 25 to 100 times nominal beam current. A value of 100 ohms is typical for 10 kW power amplifiers.

Focus electrode voltage is most conveniently and reliably obtained from a cathode resistor (R_c). Focus electrode voltage is developed across this resistor by the beam current. R_c should have ample power dissipating capability. A voltmeter should be provided to monitor the focus electrode voltage (E_{foc}) and this meter should be protected by a thyrite element.

At least two overload circuits are required, one for the beam current and one for body current. These overloads are set to trip at the values of maximum beam current and body current specified for

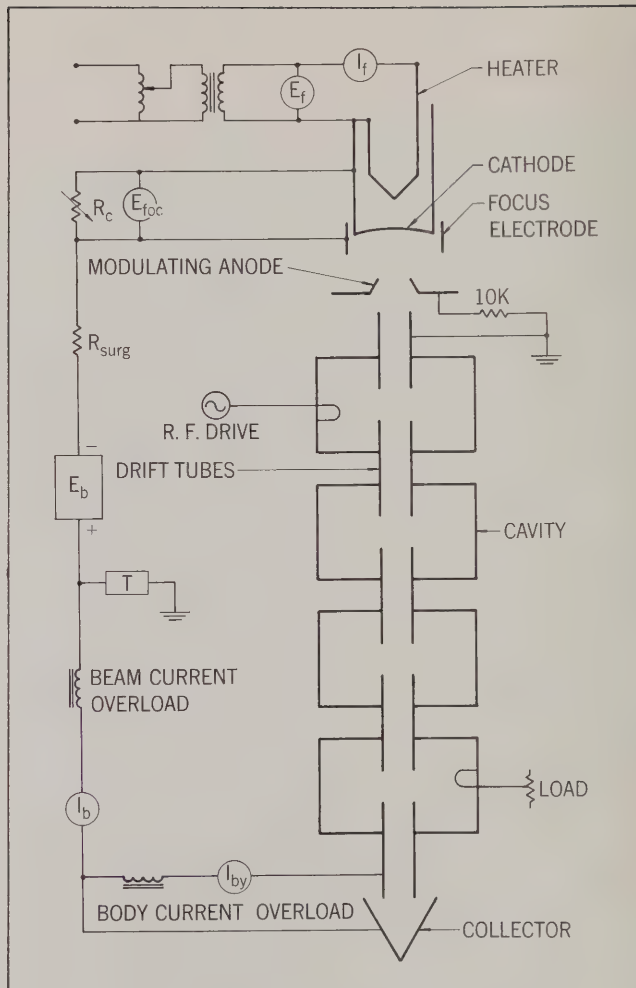


Figure 20—Klystron Power Supply Connections

the klystron. Meter relays are often used in these circuits and have been found to be satisfactory. The thyrite at T is desirable to protect the metering circuits and the klystron collector insulator in the event of power supply shorts. Every effort should be made to keep the total impedance between the klystron body (ground) and the positive terminal of the high voltage supply at a minimum. This resistance should be less than 5 ohms and one ohm is desirable.

Beam current and heater current should never be carried in the same conductor. Amplitude modulated random noise can be reduced several decibels if this rule is observed.

Beam supply ripple should be less than 1% for systems requiring incidental FM and AM noise down 40 db or more from the carrier. For noise down 60 db, 0.1% or less ripple is required. The supply should be variable or adjustable to at least four equally spaced voltage levels between 50% and 100% E_b.

Focus coil power supplies (not shown in Fig. 20) should be filtered to 5% ripple. In most cases three phase full wave supplies may be used unfiltered. The focus coils have enough inductance to reduce the ripple adequately. Means must be provided to adjust the focus coil power supply voltages over wide limits. In many cases a variable autotransformer is used with each supply to provide continuous voltage variation from zero to the maximum specified on the klystron data sheet. An ammeter must be supplied to measure the current in each focus coil. An undercurrent relay is often provided in each power supply, interlocked so that the beam power supply cannot be energized unless the focus coils are energized. The body and collector coils of many modern klystrons are operated in series from a single power supply but the prefocus coil always has a separate supply.

5.1 Modulating Anode—CW Applications

Most modern klystrons are equipped with modulating anodes. For CW applications the modulating anode is connected as shown in Fig. 20. The 10,000 ohm resistor is usually wire-wound and rated for 200 W. If the power supply and its filter capacitors stored with energy were connected directly from cathode to anode and should the slightest surface arc, gas burst or interelectrode arc take place, the full energy of the power supply would be dissipated in the tube. This energy would pass through the cathode with disastrous results. The tube would have to withstand the energy supplied and stored by the power supply until the mechanical inertia of the primary breaker and the filter capacitor shorting switch could be overcome. This situation can be somewhat improved by the use of current limiting resistors but the power loss is prohibitive if the resistance is high enough to be fully effective.

COMMONLY USED ABBREVIATIONS FOR POWER KLYSTRON CHARACTERISTICS:

- E_f —Heater Voltage
- I_f —Heater Current
- f_o —Carrier Frequency
- E_b —Beam Voltage
- I_b —Beam Current
- I_{by} —Body Current
- E_{foc} —Focus Electrode Voltage
- P_o —Output Power
- P_{in} —Beam Input Power (dc)
- P_d —Driving Power
- Im_1 —Prefocus Coil Current
- Im_{2a}—First Body Coil Current
- Im_{2b}—Second Body Coil Current
- Im_{2c}—Third Body Coil Current
- Im_{2d}—Fourth Body Coil Current
- Im_3 —Collector Coil Current

Figure 21

The problem is solved by connecting the modulating anode as shown in Figure 20. It is clear that the normal condition of negligible current to the anode does not exist at the time of the arc. When the arc occurs, a large current tends to flow to the anode. With the modulating anode connected as shown, this current is limited to a small value and has the further advantage of removing the off-cathode gradient. This extinguishes the arc and cuts off the beam current automatically in an extremely short period of time. Application of this technique at power output levels of 10 kW and above may well make the difference between a successful system and an unreliable system plagued by occasional arcs costing valuable down time.

5.2 Modulating Anode—Pulse Applications

The use of the modulating anode is very advantageous in many pulse applications. By use of this additional element it is possible to switch the tube directly across the beam power supply without the use of conventional storage networks which impose severe restrictions on the switching tubes. However, in order to take full advantage of this desirable modulation property, it is necessary to build a modulator which can efficiently drive this high impedance electrode with high voltage pulses. A new type of circuit has been developed to meet this need.

The pulse voltage can be applied to the modulating anode with a pulse transformer. However, for high voltage long pulse applications, variations of the circuit shown in Figure 22 are used. These circuits use two hard switching tubes. One tube is used to switch the anode up to operating potential, and the other to pull the anode back to cathode potential thus cutting off the beam. Rise and fall times of less than 1 microsecond through 60 kv have been achieved with jitter down in excess of 40 db.

The circuit shown in Figure 22 consists essentially of two switch tubes in series. The lower switch tube drives the modulating anode positive with respect to the klystron cathode, causing beam current to flow. The current supplied by the switch tube is only the charging current to the anode and associated circuit capacitance. This tube usually conducts during the full length of the pulse, but the dissipation is negligible because the voltage drop across the switch tube is small and the conduction current consists of only the leakage current and the intercepted beam current both of which are small. The upper

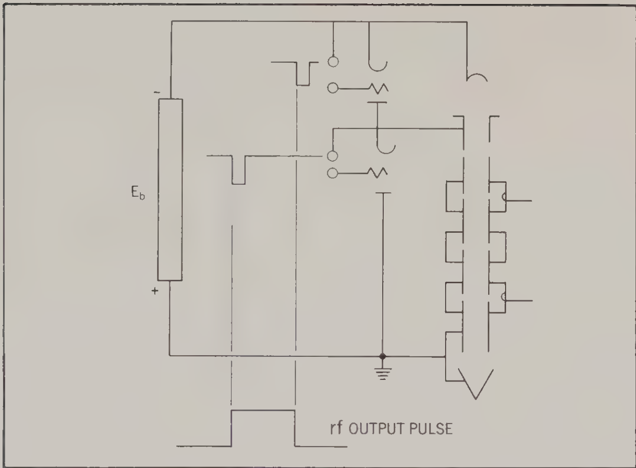


Figure 22

tube is triggered at the end of the pulse, shorting the modulating anode back to the cathode and cutting off the beam. This arrangement is known as the floating deck circuit because the circuitry which drives the lower tube must float with the modulating anode.

This circuit arrangement is particularly useful in long pulse applications because the switching tubes must work only during the rise and fall time of the pulse.

In addition, this circuit is desirable where adjustable pulse length is required. Pulsers have been made which generate a continuously variable pulse length from a few microseconds to several milliseconds.

5.3 Broad-Band Applications

External cavity klystrons are well suited to broad-band applications because the cavities can be loaded with external resistive loads to increase the bandwidth of the klystron. The circuit assemblies for many Eimac external cavity klystrons include provisions for coupling external loads to the cavities and, in other cases, coupling loops or load couplers for this purpose can be supplied on special order. The input cavity, second cavity and penultimate cavity are ordinarily loaded for broad-band operation. For extreme bandwidth, stagger tuning in addition to cavity loading is sometimes employed. The klystron is best adjusted for broad-band operation by using a sweep frequency source for the drive signal and adjusting the tuning and loading of the cavities while observing the output response curve on an oscilloscope. Such adjustments can also be made by the point-by-point method but this becomes very time consuming.

Driving power requirements for the klystron under broad-band conditions are greatly increased with respect to narrow-band operation. The gain of a three-cavity klystron under maximum broad-band conditions will be in the order of 20 decibels. The gain of a four-cavity klystron under these conditions will be from 30 to 35 decibels. The beam power efficiency of the klystron is also reduced in broad-band operation. Efficiencies of 30% to 40% can be expected.

The 3 db bandwidth of a properly loaded and adjusted three-cavity klystron is approximately 0.4% of the operating frequency. A four-cavity klystron under these conditions can provide bandwidths up to 1% of the operating frequency.

Section 6.0
MISCELLANEOUS

6.1 Eimac Power Klystron Catalog Numbering System

The catalog numbers for Eimac power klystrons have been designed to convey maximum information regarding the klystron. Here is an example:

4KMP10,000LF

The first number indicates number of cavities (4). The first letter is always K, indicating klystron.

The second letter, M, indicates that the tube has a modulating anode. If no modulating anode is used, the M is omitted.

The third letter, P, indicates that this is a pulse klystron. In the case of CW klystrons the P is omitted.

The second number, 10,000, indicates the maximum collector dissipation of the klystron. In catalog numbers assigned prior to May 1, 1961, this was expressed in watts, but in those assigned after that date it is expressed in kilowatts in the interest of brevity.

The next to last letter, L, indicates the general frequency band in which the klystron operates.

The last letter, F, indicates the frequency sub-band in which the klystron operates. Since no standard system of sub-band assignments exists, Eimac uses its own.

Eimac klystrons described by the letter X followed by three or four numerals are usually newly developed tubes which have not yet been assigned catalog numbers. In a few cases klystrons become so well known by their developmental designations that these are used permanently.

6.2 Klystron Gas Check

The power amplifier klystron can be used as an

ion gauge to check relative gas pressure and thus indicate the condition of its own vacuum. This technique is used in the Eimac factory and can be used to advantage in the field. The gas check is performed by applying +150 volts dc to the electrode nearest the cathode (usually the focus electrode) and —45 volts dc to the electrode next closest to the cathode (usually the modulating anode or anode). These voltages are with respect to the cathode. The heater voltage is then applied. As the cathode heats, electrons are attracted from it to the positively charged electrode and some of the electrons collide with gas molecules, dislodging electrons from these molecules and forming positive ions. These ions are attracted to the negatively charged electrode causing a current to flow in this circuit which is proportional to the density of the gas molecules in the klystron and hence to its gas pressure. With most external cavity klystrons the ion current in the —45 volt circuit is read when the electron current in the +150 volt circuit increases through 20 milliamperes. The heater voltage is usually maintained at approximately 75% of rated value so that the electron current rises slowly enough to permit accurate readings. The heater voltage should be removed immediately after measurement. If a klystron is found to have an ion current reading greater than five microamperes it should be aged in the transmitter at the lowest available beam voltage or with other aging equipment as described in Section 6.3.

The gas check circuit is shown in Figure 23. Because ion currents in the order of one microampere or less are involved, it is convenient to measure them by inserting resistors in the ion current circuit and measuring the voltage across these resistors with a sensitive vacuum tube voltmeter. With the voltmeter and resistor combination shown in Figure 23, equivalent full scale readings of 0.1, 1, 10 and 100 microamperes are available.

Because of the small currents involved, the leakage resistance across the tube elements involved in the gas check must be very high. This can be checked by watching for current indication in the ion circuit before heater power is applied.

Specific information on gas checking any particular Eimac klystron is available by writing to Eitel-McCullough, Inc., San Carlos, California.

6.3 Klystron Reconditioning or "Aging"

It is often inconvenient to recondition a klystron which exhibits excessive gas current by operating it in a transmitter. Equally satisfactory results can be obtained with the following procedure.

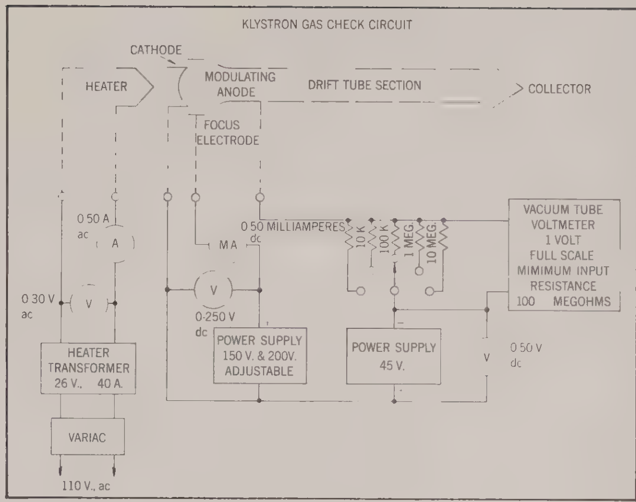


Figure 23

1. Support the klystron in a position permitting free circulation of air around the gun structure. Klystrons which are shipped in a metal frame may be aged in this frame, but those shipped in hair pack must be removed from the shipping container.
2. Apply forced air cooling to the gun structure in the amount specified in the data sheet.
3. Apply rated heater voltage to the klystron, limiting starting current to the specified value. Allow five minutes to warm up.
4. Short the focus electrode to the cathode.
5. Short the anode, drift tubes and collector together and ground.
6. Apply 500 volts ac or dc from the anode to the cathode. If dc is used the positive terminal must be connected to the anode. Cathode current will be approximately 15 to 30 milliamperes.
7. Energize the klystron in this manner for 12 hours or until the ion current, as indicated by the gas check, decreases to one microampere or less.

If the klystron has a titanium getter, it will be advantageous to energize the getter during the aging process.

6.4 Technical Assistance

Eitel-McCullough, Inc. will gladly assist users in the choice of klystrons best suited to their particular applications. This cooperation is especially important when a prototype design, which will later be manufactured in quantity, is being contemplated. Such assistance makes use of accumulated, detailed experience with the Eimac klystron types involved, and is handled confidentially and without charge.

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